APPENDIX H-6

Description of Infrastructure Components

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APPENDIX H-6
DESCRIPTION OF INFRASTRUCTURE COMPONENTS

This appendix summarizes the technical assumptions related to the infrastructure for major components in the final range of alternatives considered in the Draft Programmatic Environmental Impact Report (PEIR). This information is intended to be used along with information presented in Appendices H-1, H-2, H-3, and H-4 regarding assumptions related to habitat, hydrology, air quality, and geotechnical issues. The infrastructure of the alternatives was developed to support those functions within each alternative. The majority of the infrastructure described in this appendix is used either to divert, convey, or store water or to partition the existing Salton Sea footprint, or Sea Bed, for different uses. Therefore, the main infrastructure includes Sedimentation/Distribution Basins, canals, distribution channels, pipelines, pumping plants, water treatment plants, Air Quality Management facilities, Barriers, dikes, and Berms. The incorporation of these components in the alternatives is described in Appendix H-7.

LEVEL OF DETAIL AND GENERAL ASSUMPTIONS FOR INFRASTRUCTURE COMPONENTS

The information presented in this appendix was prepared for a programmatic level of detail to allow estimates of construction quantities for different combinations of infrastructure in the final alternatives considered in the PEIR, as described in Appendix H-7. Detailed evaluations in future project-level analyses would refine specific estimates of the required infrastructure. In many cases, this appendix discusses a range of possible infrastructure designs that could achieve the various hydraulic, structural, and site objectives. For example, multiple designs for Barriers across the Sea Bed currently are being considered by several agencies and interest groups. However, for the programmatic purposes of the PEIR, only one option is described with discussions of how other infrastructure options could be incorporated.

Each alternative described in Chapter 3 and Appendix H-7 would use Barriers and/or conveyance systems to partition the Sea Bed into areas that preserve, create, or mitigate the effects of reduced inflows into the Salton Sea. Each area would be sized and configured based on inflow projections, as described in Appendix H-2. The water conveyance systems would be sized to convey the water of appropriate quality and quantity for each area. Conveyance of both saltwater and fresh or brackish water to the various areas generally requires separate facilities. The purpose of each conveyance system and the required facilities to support its function are described below.

All facilities would be constructed in phases and would be designed to accommodate both initial and long term needs. Facilities also must adapt to changed conditions as the water recedes.

Details of the conceptual facilities presented in figures and tables included in this appendix are presented for comparison purposes. During project-level analyses, detailed evaluations of several construction methods should be analyzed.

COMPONENTS CONSIDERED IN THE ALTERNATIVES

The alternatives were developed to provide a wide range of programmatic alternatives, as described in Chapter 2. Several of the alternatives include Partial Sea components that provide water bodies in a portion of the Sea Bed with 50-foot deep marine and/or brackish water bodies. Other alternatives include Non-Sea Habitat components, referred to as Saline Habitat Complex cells, with shallower water in partitioned areas to provide a habitat mosaic. These components would be formed by a combination of infrastructure facilities described in this appendix, as summarized in Table H6-1. Not all infrastructure facilities would be included in every alternative. The specific combinations of facilities in each alternative are described in Chapter 3 and Appendix H-7.

GENERAL ASSUMPTIONS

The proposed infrastructure for each alternative would be constructed primarily within the Sea Bed, and, therefore, below -228 feet mean sea level (msl) contour which would minimize impacts to the adjacent existing land uses and infrastructure including agricultural drains, roadways, agriculture, storm drains, and power. Because the Sea Bed is presently inundated, the soil and groundwater characteristics cannot be specifically determined until the water recedes. Assumptions related to access to construction sites, limitations due to climate and air quality conditions, water quality considerations, and geotechnical conditions in the area have been applied to all of the alternatives analyzed in the PEIR. It should be noted that the term "shoreline" as used in the PEIR refers to the existing shoreline located at about -228 feet msl.

Access

Access to the Salton Sea would be provided through a number of existing highways and roads. The main roadways adjacent to the Salton Sea parallel the shoreline on the eastern and western sides. State Highway 111, on the eastern side of the Salton Sea, is generally located within 1 to 2 miles of the shoreline. A Union Pacific Railroad line parallels State Highway 111 for the entire length of the Salton Sea. A mining railroad, about 50 miles in length, extends from the Eagle Mountain Mine to the Union Pacific Railroad near the eastern shore of the Salton Sea. A separate mining railroad extends from Mesquite Mine about 10 miles to the Union Pacific Railroad at a location about 25 miles south of the Salton Sea. State Highway 86, on the western side of the Salton Sea, is generally within 1 to 4 miles of the shoreline. Access to the northern and southern ends of the Salton Sea is generally by local roads. Interstate 10, an east/west roadway between Los Angeles and Phoenix, is located about 11 miles north of the Salton Sea. Interstate 8, an east/west roadway between San Diego and Yuma, is located about 23 miles south of the Salton Sea.

The existing roads and the Union Pacific Railroad would allow construction equipment to be delivered to the vicinity of the Salton Sea. New construction roads would be needed in many areas near the shoreline and throughout the Sea Bed.

For the purposes of the PEIR, extensions of major roadways and railroads or construction of conveyors were not included in the alternatives. Inclusion of these facilities would reduce traffic on local roads and could reduce vehicle emissions. However, construction of the roads or railroads could cause adverse impacts to biological resources along potential routes. During project-level analyses, the feasibility of extending access routes could be considered for all or a portion of construction activities. The project-level analyses also could consider primary and secondary access areas in different locations along the shoreline to minimize impacts to the surrounding land uses. These facilities could be included in any of the alternatives analyzed in the PEIR with both increased benefits and impacts associated with alternatives that require large amounts of delivered materials. Therefore, inclusion or exclusion would not change the relative differences between alternatives for the resources evaluated in the PEIR.

Climate and Air Quality

The climate of the Salton Sea watershed area is typical of a desert regime with large daily and seasonal fluctuations in temperature. High temperatures frequently exceed 100^{o} Fahrenheit in the summer. During the winter, temperatures can drop to near or just below freezing. As described in Chapter 10, high winds frequently occur throughout the year. High temperatures could require special design considerations but would not be expected to limit construction activities. High winds may cause extreme waves and limit loading, off-loading, and operating activities for barges.

Table H6-1
Major Infrastructure Features in the Alternatives

	Alternatives									
Component	**No Action Alternative - CEQA Conditions**	**No Action Alternative - Variability Conditions**	**(1) Saline Habitat I Alternative**	**(2) Saline Habitat Complex II Alternative**	**(3) Concentric Rings Alternative**	**(4) Concentric Lakes Alternative**	**(5) North Sea Alternative**	**(6) North Sea Combined Alternative**	**(7) Combined North and South Lakes**	**(8) South Sea Combined Alternative**
Air Quality Management Canal	•	•	•	•	•	-	•	•	-	•
Pupfish Channel	•	•	•	-	-	-	-	•	-	-
Marine Sea Recirculation Canal	-	-	-	-	-	-	•	•	•	•
River Bypass Pipelines	-	-	-	-	•	•	-	-	-	-
Pumping Plants	-	-	-	•	•	-	•	•	•	•
Saltwater Conveyance Canal or Pipelines	-	-	-	•	-	-	•	•	-	-
Marine Sea (including Recreational Saltwater Lake in Alternative 7)	-	-	-	-	-	-	•	•	•	•
Marine Sea Mixing Zone (including Recreational Estuary Lake in Alternative 7)	-	-	-	-	-	-	-	•	•	-
First and Second Concentric Rings	-	-	-	-	•	-	-	-	-	-
First, Second, Third, and Fourth Concentric Lakes	-	-	-	-	-	•	-	-	-	-
Saline Habitat Complex without a Shoreline Waterway	-	-	•	-	-	-	-	-	•	-
Saline Habitat with a Shoreline Waterway	-	-	-	•	-	-	•	•	-	•
Sedimentation/ Distribution Basins	•	•	•	•	•	•	•	•	•	•
Barriers	-	-	-	-	-	-	•	•	•	•

Table H6-1
Major Infrastructure Features in the Alternatives

Component	Alternatives									
	No Action Alternative - CEQA Conditions	No Action Alternative - Variability Conditions	(1) Saline Habitat I Alternative	(2) Saline Habitat Complex II Alternative	(3) Concentric Rings Alternative	(4) Concentric Lakes Alternative	(5) North Sea Alternative	(6) North Sea Combined Alternative	(7) Combined North and South Lakes	(8) South Sea Combined Alternative
Perimeter Dikes	-	-	-	-	•	-	•	•	•	•
Berms	-	-	•	•	-	•	•	•	•	•
Air Quality Management with Water Efficient Vegetation	•	•	•	•	•	-	•	•	-	•
Air Quality Management with Brine Stabilization without Salt Crystallizer Ponds	•	•	•	•	•	-	•	•	-	•
Air Quality Management with Brine Stabilization with Salt Crystallizer Ponds	-	-	-	-	-	-	-	-	•	-
Marine Sea Outlets	-	-	-	-	•	-	•	•	•	•
Outlet/Spillway	-	-	-	-	•	•	•	•	•	•
Imperial Irrigation District Reservoir	-	-	-	-	-	-	-	-	•	-
Treatment Plants	-	-	-	-	-	-	-	-	•	-

Notes
• = component included
- = component not included

The air quality for both Imperial and Riverside counties is classified as being in “nonattainment” for several air quality pollutants. As described in Chapter 10 and Appendix E, the existing nonattainment designation could significantly limit additional dust and diesel engine emissions during construction and lengthen the construction period to avoid exceeding air quality standards during construction. For purposes of estimating infrastructure needs and construction activities, schedules were developed with specific assumptions used in the Air Quality analysis presented in Chapter 10 and Appendix E. These schedules are included in the descriptions of alternatives in Appendix H-7.

Salton Sea Water Quality

Salton Sea inflows are primarily from agricultural and municipal runoff and municipal wastewater effluent. This results in unique water quality characteristics as described in Chapter 6 and Appendix D. Existing Salton Sea salinity is about 48,000 mg/L and would significantly accelerate corrosion of some materials. Brine salinity would exceed 350,000 mg/L. The saline water would significantly impact pump and conveyance performance since saline water is denser than fresh water and tends to accumulate on equipment. The Salton Sea Salinity Control Research Project (Reclamation, 2004) describes many of the problems, such as gypsum and biological fouling, which can affect the operation of facilities that operate with high salinity water and brine.

Inflows to the Salton Sea can also include significant silt loads. The silt currently deposits at the confluences of the New, Alamo, and Whitewater rivers and form deltas at these locations. Silt deposits in at least two of the delta regions are periodically dredged to prevent the rivers from changing course and to prevent the rivers from backing up and depositing silt upstream of the Salton Sea. In the alternatives analyzed in the PEIR, Sedimentation/Distribution Basins would contain and manage silt from the rivers prior to diversion for uses.

Hydrogen sulfide and nutrients could substantially affect operations of the habitat components, as described in Appendix D. The water quality issues are assumed to decrease throughout the study period; and, therefore, water treatment was not included in most of the alternatives. However, to provide a range of alternatives in the PEIR, one of the alternatives includes water treatment.

Geotechnical

Site-specific geotechnical conditions, such as faulting/seismicity and low strength clays of the Sea Bed, would directly influence all infrastructure designs. Two fault zones bound the Salton Sea rift zone: the San Jacinto Fault Zone on the southwestern margin and the San Andreas Fault Zone on the northeastern margin, as described in Chapter 9. Each of these fault zones is comprised of multiple sub-parallel faults that have right-lateral and/or vertical separation (Babcock 1974). Potential earthquakes on these faults would significantly influence design and construction of facilities in the Sea Bed.

Soil units within the Salton Trough and Lower Colorado River region have formed on fine-grained sediments associated with the occurrence of Lake Cahuilla, the Colorado River, and alluvial fans from the adjacent highlands. Most of the Sea Bed soils appear to be low strength clays that can make poor foundations for infrastructure based upon previous studies. Foundation replacement, pile supported facilities, or settlement allowances must be considered.

Groundwater elevations near the Salton Sea can occur within a few feet of the ground surface, as described in Chapter 7. As the water recedes, the high groundwater could influence the ability to excavate and properly compact embankment materials for Berms, roadways, and other facilities. High groundwater could also increase construction costs if deep excavations must be dewatered during construction activities. The alternatives do not include additional time or costs associated with the need for dewatering or special foundation treatment.

PROJECTED INFLOWS

Inflows are projected to decline over the next 75 years, as described in Chapter 5 and Appendix H-2. Inflows would be relatively stable until 2017. Then, inflows would decline substantially until the mid 2030s. Inflows are projected to be relatively stable until the mid-2050s when another slight reduction would occur. Relatively stable flows are projected from the mid-2050s until the end of the study period in 2078. Seasonal fluctuations would occur throughout the study period.

A water balance was developed for each alternative based on specific assumptions related to prioritization of water use, placement of specific water bodies to provide habitat or other uses, flow rates in each component, and evaporation from surface waters. The alternatives were developed to accommodate inflow fluctuations on both an average annual basis and seasonally. In most alternatives, the Brine Sink and Air Quality Management areas were designed to fluctuate. However, during the development of alternatives, water use tradeoffs were considered and facilities were moved to provide maximum flexibility without compromising habitat features. For example, for a given minimum design inflow, if the Saline Habitat Complex increased in size, then other water features would be reduced in size to maintain the water balance. The layout of all water consuming features was developed to minimize risk if inflows were reduced further than anticipated in the PEIR. The risk management approach for all alternatives provides the highest priority to Saline Habitat Complex with or without Shoreline Waterway. Water demands were not included for Pupfish Channels because it was assumed that the channels would be extensions of drains.

Historically, inflows were generally highest in the spring and lowest in the winter. It is difficult to predict if the future inflow patterns would be the same. For example, agricultural drainage flows could change due to crop shifts and on-farm conservation practices. To accommodate these uncertainties, facilities must function with a variety of inflow conditions and be adaptable to possible shifts in inflows.

The most critical facilities related to projected inflows are the Marine Sea and Saline Habitat Complex because these areas require the greatest water use per surface area and they would be constructed with Barriers, Perimeter Dikes, and Berms that would be difficult, and may not be practical, to move following construction.

Use of SALSA Model in Developing Infrastructure and Assessing Tradeoffs

Various Marine Sea configurations were analyzed with a range of inflows using a model that was developed to account for changes in annual water and salt balances under varying hydrologic assumptions, as described in Appendix H-2. The model, named SALSA, incorporates the major components and approximates the hydrologic water needs of each.

The SALSA model approximates the water demands based on evaporation, evapotranspiration, and seepage that would occur in the Saline Habitat Complex, Marine Sea, Brine Sink, Air Quality Management Areas, and Water Treatment components. Using bathymetry of the Sea Bed, the volume of the water bodies are calculated for specific locations. Elevation targets can be specified for each component. The model also calculates salinity for each component.

The allocation of inflows used in the model is distributed among: (1) Water Treatment, (2) Saline Habitat Complex and Shoreline Waterway, (3) Air Quality Management, (4) Marine Sea and Marine Sea Mixing Zone, and (5) Brine Sink. Treatment consumptive uses are given first priority. The resulting flows are allocated to Saline Habitat Complex and Air Quality Management, and then to the Marine Sea. Air Quality Management receives the highest priority because air emissions must be controlled in all alternatives. The managed Saline Habitat Complex receives second priority because this habitat value per surface acre may be higher than a Partial Sea, as described in Appendix H-1. Marine Sea areas were sized based on the 80 percent exceedance inflow after water is allocated for Air Quality Management and Saline Habitat Complex.

The location of the Saline Habitat Complex is provided as an input to the model. The Marine Sea elevation and salinity are computed in the model. Salinity in the Marine Sea is a function of inflow and outflow relationships. The model prioritizes Marine Sea elevation control over salinity. Water is used to flush salts through the Marine Sea if facilities are available. Flows not needed for other purposes are spilled to the Brine Sink.

Consumptive water demands for Water Treatment, Saline Habitat Complex, and Air Quality Management are computed in the SALSA Model as the product of the assumed area and the approximated evapotranspiration rate of the vegetation or evaporation rate of the open water, including adjustments for salinity and assumed global climate changes. The area for Air Quality Management is computed based on the Exposed Playa area.

Setting appropriate targets for Marine Sea elevations, Marine Sea salinity, Saline Habitat Complex areas, Water Treatment, and other water consumptive uses may require tradeoffs to achieve balance. For alternatives with a Marine Sea, the following tradeoffs were considered if there was insufficient inflow water to meet a Partial Sea elevation and/or salinity targets for a given Barrier location:

- Reduce Marine Sea elevation target for a given Barrier location;
- Move the Barrier location to reduce the size of Marine Sea for a given elevation target;
- Adjust both Marine Sea elevation target and Barrier location;
- Increase the Marine Sea salinity target (i.e. meet 45,000 mg/L rather than 35,000 mg/L);
- Adjust Marine Sea elevation target, Barrier location, and salinity target; and
- Accept a high risk of not achieving an elevation or salinity target in any given year. This could occur if the Marine Sea is sized for average annual inflows that may not occur in all years based upon inflow projections.

Adjusting the Marine Sea elevation and salinity targets directly influences the placement of the Barrier and the related infrastructure. For instance, a lower Marine Sea elevation or higher salinity target could move the Barrier closer to the middle of the Sea Bed, and, therefore, reduce the Barrier height and length. A lower Marine Sea elevation target also would reduce the Barrier height.

Adjusting these targets also can influence the placement and alignment of canals and Air Quality Management Areas. A lower Marine Sea elevation target could allow less pumping plants on the conveyance systems. However, managing the Exposed Playa above the Marine Sea elevation target could require pumping plants for Air Quality Management.

For the purposes of the PEIR, a target water surface elevation of -230 feet msl was used for open water areas adjacent to the shoreline. This provides an equivalent basis to evaluate the range of alternatives. It is anticipated that during project-level analysis, facility placement, water surface elevation targets, and salinity targets would be considered to optimize the configuration.

Consideration for Flood and Other Peak Flow Events

While flood and peak flow events contribute to the annual inflow volumes into the Salton Sea, it is not practical to oversize all conveyance facilities for these rare flow events. However, peak flood events must be considered in the design of the alternatives. Flood events are typically a function of local hydrology and would occur into the future. A flood event can adversely impact infrastructure and the habitat functions if not managed or diverted. Flood protection measures could include outlet structures, oversized delivery canals to convey flows, and/or erosion protection to protect infrastructure during high flows.

Several U.S. Department of the Interior, Geological Survey (USGS) daily stage and flow gages are located on each of the major tributaries. This data can be used in sizing Sedimentation/Distribution Basins and conveyance features. Information on historical daily, monthly, and annual flows is presented in Appendix H- 2 and summarized below.

New River

USGS gage number 10255550 on the New River near Westmorland has recorded river flows since January 1943. The maximum daily flow during this period was 3,000 cubic feet/second and the minimum daily flow was 150 cubic feet/second. Based on this data, about 99.5 percent of the New River flows can be captured if facilities were sized to convey up to 860 cubic feet/second. However, if the facilities were sized for 750 cubic feet/second, only 98 percent of the New River flows could be used in the facilities.

Alamo River

USGS gage number 10254730 on the Alamo River near Niland CA has recorded river flows since October 1960. The maximum daily flow during this period was 4,500 cubic feet/second and the minimum daily flow was 288 cubic feet/second. Based on this data, about 99.5 percent of the Alamo River flows can be captured if facilities were sized to convey up to 1,200 cubic feet/second. However, if the facilities were sized for 1,050 cubic feet/second, only 98 percent of the Alamo River flows could be used in the facilities. This information is important in sizing the Sedimentation/Distribution Basins and in determining probable overflow spill frequencies throughout the study period. In sizing canals and pumping plants, flow criteria did not incorporate high flow events in the watershed because the facilities would convey water only to specific components and would not be designed to accommodate flood flows.

Whitewater River

USGS gage number 10259540 on the Whitewater River near Mecca has recorded river flows since October 1960. The maximum daily flow during this period was 2,500 cubic feet/second and the minimum daily flow was 37 cubic feet/second. The peak events indicate that the Whitewater River is more influenced by storm event flows than the New and Alamo Rivers, as discussed in Appendix H-2.

Salt Creek

USGS gage number 10254050 on Salt Creek near Mecca has recorded flows since February 1961. This gage was used because it is the closest to Salt Creek. The maximum daily flow during this period was 2,820 cubic feet/second and the minimum daily flow was 0 cubic feet/second. Storm events from this watershed are extreme and must be anticipated in infrastructure design to avoid flooding or the introduction of massive amounts of freshwater into saline water bodies.

San Felipe Creek

USGS gage number 10255885 on the San Felipe Creek near Westmorland has recorded flows since December 1960. The maximum daily flow during this period was 17,100 cubic feet/second and the minimum daily flow was 0 cubic feet/second. The extreme flow occurred on September 10, 1976 as a result of Hurricane Kathleen. Climatological data (NOAA, 1976) shows that many of the rainfall stations to the west of the Salton Sea recorded 2 to 6 inches of rain in one day during the hurricane. In response to this rainfall event, the Salton Sea surface water elevation increased about 9 inches. This is one example of the extreme rainfall events that must be considered during project-level design of facilities to avoid flooding or introduction of massive amounts of freshwater into saline water bodies.

Timing of Reductions in Future Inflows

The timing of future inflow reductions is important in the design and construction of the infrastructure. The water elevation and salinity conditions described under the No Action Alternative would persist until facilities are completed and water diverted to the various components. In many alternatives, the timing of inflow reductions would determine when habitat and other components can be developed. For example, facilities constructed using water-based operations (barges, dredges) could not be constructed if water elevations recede before Barriers or Perimeter Dikes are complete. Some facilities must be constructed on exposed land, such as Air Quality Management Canals. This construction could not happen if the water has not receded within anticipated time periods. In addition, if inflows do not decline as rapidly as projected in the PEIR, salinity would remain lower than projected. Conversely, if inflows declined more rapidly than projected, salinity in the Marine Sea would increase more rapidly than projected.

During project-level analyses, it will be important to develop a more detailed analysis of inflow patterns during the construction and initial operations periods. This analysis also should consider flexibility if permit conditions lengthen the construction period. This could cause construction impacts if Barrier construction required specific water elevations.

For purposes of this PEIR, a proposed implementation schedule was developed for each alternative, as described in Appendix H-7. This schedule was used to determine when facilities would be operational, and benefits and impacts would occur. Each alternative was simulated in the SALSA model using these schedules, as described in Appendix H-2.

Use of the Brine Sink to Modulate Flows to Components

The Brine Sink performs an important function by providing an outlet for salt from all other components. The Brine Sink also would serve as an overflow area when inflows exceed the water needs of other components. Excess water in the other components could flood facilities or change the salinity. For example, the Marine Sea salinity could decline and not support marine habitat if too much freshwater entered the Marine Sea during floods. Therefore, flood flows would be channeled to the Brine Sink. Channels would be established on the Sea Bed to avoid damage to Air Quality Management components from unmanaged flood flows from the Sedimentation/Distribution Basin or creeks.

Each component would require a relatively stable water supply. However, due to the hydrologic variations and uncertainty of long term sustained flows, each alternative must have some flexibility to accommodate this uncertainty. The Brine Sink would be used for regulation of the water supply, and receive more water during wetter periods and less during dry periods.

PUPFISH CONNECTIVITY CONSIDERATIONS

Connectivity for desert pupfish between the drains entering directly into the Salton Sea would be maintained for all alternatives. However, it would not be possible to provide connectivity through a large open water body, such as the Salton Sea, when salinity becomes too high to support the desert pupfish. A hydraulic connection between as many drains as possible would be provided to create some connectivity. Desert pupfish connectivity in some alternatives would be provided in the open water located along the shoreline, such as a Shoreline Waterway for Saline Habitat Complex, Marine Sea, or Concentric Ring or Lake. If open water is not located adjacent to the shoreline, a Pupfish Channel would be constructed along the shoreline at the lower end of each drain. In most of the alternatives, including the No Action Alternative, the desert pupfish communities would be separated into two or more groups. To maintain desert pupfish connectivity, conveyance canals would be constructed under the Pupfish Channels or open water that provides connectivity.

Pupfish Channels would be unlined channels with the same water quality as the tributary drains. Pupfish Channels would be maintained by dredging every two to three years to remove silt and vegetation.

Maintaining salinity of at least 20,000 mg/L within a Shoreline Waterway, Concentric Ring or Lake, or Marine Sea would minimize vegetation management activities, minimize selenium ecorisk potential, and inhibit desert pupfish predators. Water velocities would be less than 0.1 feet/second in these water bodies to accommodate desert pupfish habitat.

WATER CONVEYANCE CONSIDERATIONS

Much of the infrastructure for the alternatives is for the movement, or conveyance, of fresh water or saline water over many miles. Since the New and Alamo rivers convey the majority of inflow, the conveyance of those flows generally requires the largest conveyance facilities.

The infrastructure was designed to function with an average inflow as low as 600,000 acre-feet/year. Each alternative also was evaluated to function at inflows up to 1,200,000 acre-feet/year and to convey flood flows through the facilities with little damage. This would provide the alternatives with flexibility to operate with a wide range of inflows that could be further refined during project-level analyses.

Overall Conveyance System Concept

For water to flow primarily by gravity, head loss in the conveyance systems must be minimized. This can be accomplished by: slowing the water velocities by constructing larger canals or pipelines, lining channels, or by reducing the number of canal transition sections. Alternatively, pumping plants can be used to overcome the head loss. In many alternatives, canals would be confined to narrow areas along the shoreline to avoid conflict with adjacent land uses or other features.

Diversion and Distribution Facilities

The diversion points from the New and Alamo rivers were generally chosen to be near the confluences with the Salton Sea. The objective was to divert the water from the rivers near -228 feet msl to minimize backwater effects on upstream drains. All of the conveyance facilities were assumed to be within the area of the existing Sea Bed.

Diversion locations several miles upstream were considered since the river elevations would be higher and provide more hydraulic grade for the conveyance facilities. However, these locations were not included in the alternatives due to potential adverse impacts on large amounts of agricultural land and/or habitat. However, during project-level analysis, specific locations of the diversions and Sedimentation/Distribution Basins would need to be considered in detail including impacts on the overall hydraulics of the system.

Sedimentation/Distribution Basins would collect and distribute the major inflows into one or more components. The Sedimentation/Distribution Basins would reduce the water velocities and allow settlement of suspended sediments. The decanted water would flow into conveyance systems. These basins would not be water storage areas, so water exceeding the canal capacity or water demands would flow into other areas or the Brine Sink. In some alternatives, the Whitewater and New rivers flow directly into the Marine Sea or Marine Sea Mixing Zone because the amount of fresh water and sediment can be assimilated without major operations and maintenance issues in the large water bodies as compared to conveyance facilities or Saline Habitat Complex.

Managing Inflows and Salinity

Conveyance systems would regulate flows to control water quality for each component. For example, the Marine Sea salinity would be balanced by controlling both the inflows and outflows using flow regulation gates and conveyance facilities. Also, the saltwater outflow could be conveyed to supply a portion or all of the Saline Habitat Complex water needs.

The Air Quality Management areas also would require water distribution from both fresh water and saltwater sources which would be blended to provide appropriate salinity for the vegetation. The Saline Habitat Complex would require conveyance and blending of fresh water inflows with saltwater from the Marine Sea, Brine Sink, or other salt source to achieve the desired inflow quantities and salinity.

Narrow bodies of marine quality water, such as Marine Sea Mixing Zones in several alternatives, would require recirculation of saltwater. This recirculation of saltwater would require a large canal and/or pumping plant to circulate between 400 and 1,000 cubic feet/second depending on the alternative.

Water Uses and Conveyance Sizing

In most alternatives, water was assumed to be conveyed at a peak flow to support the evapotranspiration and evaporation of specific components. Estimates of the average monthly evapotranspiration and evaporation were computed and are accounted in the SALSA model. Peak daily flow needs for the components are listed in Table H6-2. Peak values would change over time and with salinity, as represented in the SALSA model.

Table H6-2
Peak Conveyance Flow Criteria as Calculated by the SALSA Model

Component	Peak Conveyance Flow (cubic feet/second/square mile)
Marine Sea	12.9
Saline Habitat Complex	12.9 minus saltwater inflow
Water Efficient Vegetation	
Freshwater Inflow	3.5
Saltwater inflow	0.9
Stabilization with brine	0.9
Brine Sink	Not applicable

GENERAL CONVEYANCE FACILITY DESCRIPTIONS

This section describes canals, pipelines, pumping plants, and other conveyance systems.

Canals

Where possible, unlined, earthen canals would be used instead of pipelines or concrete lined canals. In general, unlined excavated canals are less expensive than pipelines given the open rural land and could provide many operational benefits due to the relatively flat slopes around the shoreline and Sea Bed. To avoid impacts to existing land uses, most canals would be located near the shoreline in areas that would become exposed as the water recedes. This would allow construction during Phase I and avoid conflicts with utilities and road crossings. A typical canal arrangement showing multiple canals along the upper contours of the Sea Bed is shown on Figure H6-1.

Seepage is unlikely to be a significant issue since water would typically flow in excavated sections similar to existing drains in the area. Specific efforts to seal localized seepage could be performed as necessary. In addition, canal water demands would be less in initial years so this is unlikely to be a significant issue. Seepage potential and canal alignments would be investigated during project-level analyses.

Canal Capacity

The capacity of each canal would depend on the size and purpose of the component being served. For this analysis, the peak flow values were multiplied by the size of the area being served to obtain the canal capacity. A canal could convey water for more than one purpose and be of sufficient size to account for water demands through Phase IV. For example, a canal may convey fresh water for Saline Habitat Complex areas and for Air Quality Management. Sizing considerations would need to account for the uncertainty of each component and future locations.

Canals to convey water to a Marine Sea would be sized to deliver an annual volume of water as required by the water balance to support target salinity and elevation. The canal size would be based on the peak demand during the year. For most of the alternatives, the Marine Sea would receive only about 400,000 acre-feet/year of the total inflow. This volume of water would typically be captured in the Sedimentation/Distribution Basin and distributed to the Marine Sea as described later.

Canals could convey excess flows in some alternatives. Excess flows eventually would be conveyed to the Brine Sink after all other beneficial uses.

Canal Cross Section Design Considerations

The U.S. Department of the Interior, Bureau of Reclamation (Reclamation) publication, *Canals and Related Structures*, (Reclamation, 1967) was used for general guidance for canal sizing and design. Trapezoidal cross sections, with 2 horizontal to 1 vertical size slopes (2:1), were used for all canals. In most cases, maximum velocities would be less than about 1.5 feet/second to reduce head loss. The Manning's formula was used with an "n" value of 0.025 to compute the canal sizes for unlined sections and 0.013 for concrete lined sections.

Most of the canals would be expected to follow the upper contours in the Sea Bed. The maximum water levels in the canals would be at the natural or existing ground level. The freeboard on the canals would be provided by extending the cross section above natural ground with Berms constructed from the excavated material.

The largest canals would have flows over 200 cubic feet/second and would have at least 5 feet of freeboard above the canal water surface. Canal embankments above the excavation would be constructed from the compacted excavated materials. These embankments would provide access along each side of the canal. The canal roadways would be just above the existing ground elevations on each side. The canals could have security fencing on at least one side of the canal for safety reasons. Bridges would be provided for access across the larger canals at five mile intervals.

Smaller canals would have flows less than 200 cubic feet/second and would have a minimum of 3 feet of freeboard.

High groundwater encountered during construction could make dredges more cost effective for canal excavation; however, traditional excavators could also be used.

Headworks

Canals designed to convey water by gravity from Sedimentation/Distribution Basins would start at gated headworks to control flow into the canal. Gated control structures could include radial gates, slide gates, or adjustable overflow weirs. These facilities would be used to regulate flows into the canal systems so they are not overtopped or drained quickly during operations. Headworks facilities function best for control when they divert water from a pool of water with constant depth. The Sedimentation/Distribution Basin would provide the stable pool of water.

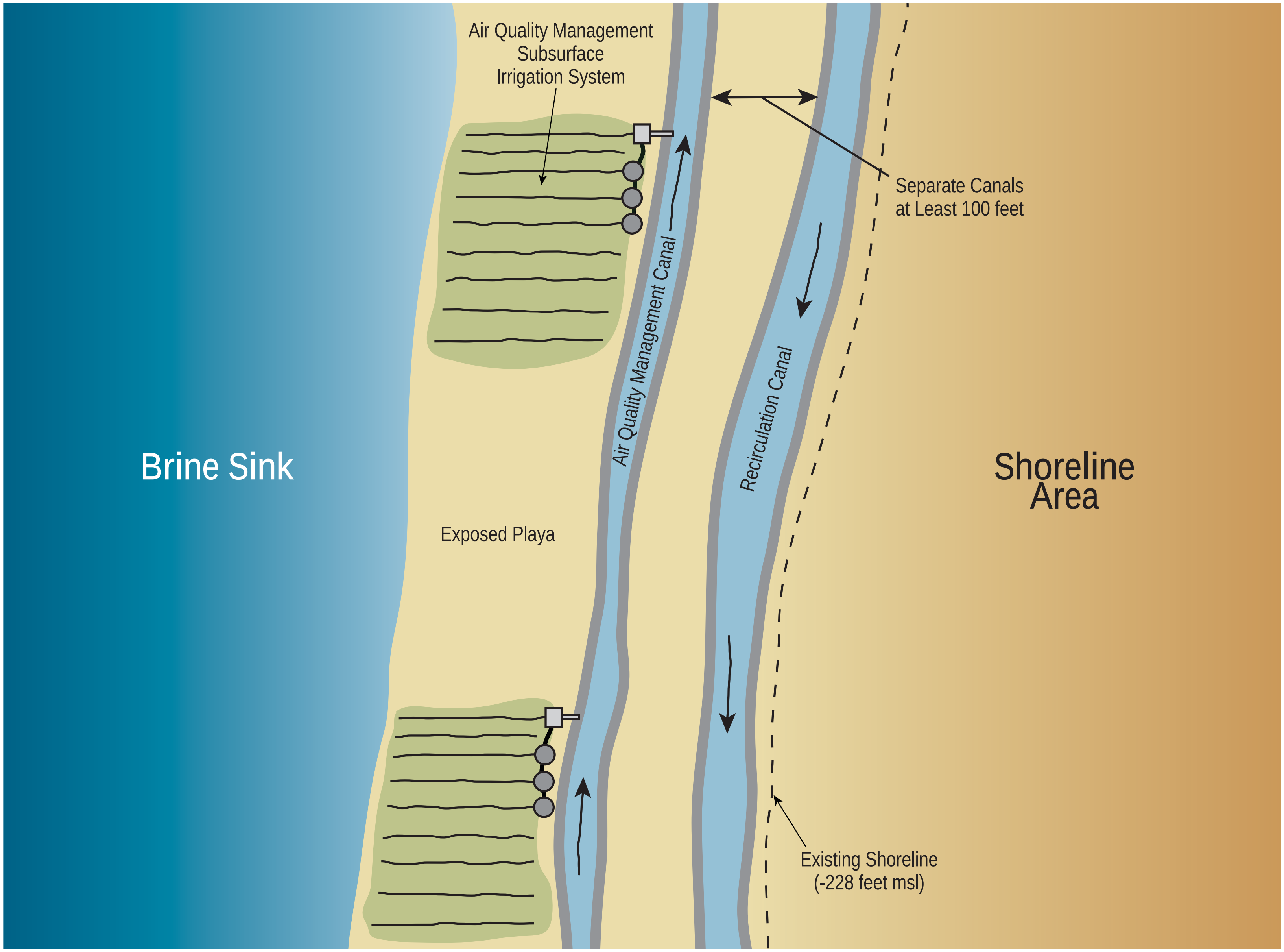


FIGURE H6-1
CANAL LAYOUT SHOWING MULTIPLE CANALS

To minimize sediment maintenance in the canal sections, a submerged wall or decanting weir upstream of the headworks control gate would prevent a majority of the inflow sediment load from entering the system. Keeping the majority of the sediment isolated to one area would be desirable for maintenance purposes.

Specific configurations, siting layouts, and facilities would be determined in project-level analysis. For estimating purposes, a radial gate structure, sized appropriately for each canal, was assumed in the alternatives. These facilities would be similar to typical irrigation and distribution canal systems.

Cross Drainage Structures

A variety of structures would be used where a canal alignment must cross an existing waterway such as a drainage canal, natural tributary creek, or other waterway. For most configurations, the drainage or tributary water flows would not be desirable to enter the canals. Therefore, the canal would cross under or over the waterway. In some cases, training dikes or hardened sections could be constructed to prevent the crossing waterway alignment from changing course.

For most natural drainages, drainage water would be conveyed in an overshoot structure across and over the canal. In the case of a larger tributary or drainage flows, such as San Felipe Creek, the canal could siphon under the drainage, or the canal could be designed to allow peak natural flows to drain directly into the canal and then spill over the other side. A small section of canal (up to 50-foot long) could be concrete lined to protect the canal from turbulence from the water entering the canal and allowing it to be spilled in a low section on the other side.

In most cases, the canal would pass under the drainage in a concrete siphon structure. These structures would be fitted with streamlined warped wing walls to minimize canal head losses through the facility, as shown in Figure H6-2.

Canal Check Structures and Wasteways

Check structures allow canal water surface elevations to be controlled along long canal lengths. Check structures can consist of radial gates, adjustable slide gates, or adjustable overflow weirs. For the alternatives, each canal is assumed to have one check structure with radial gate(s) to maintain upstream water surface elevations for each 2 feet of canal drop. Just upstream of each gate, a wasteway weir would be designed to divert excess flows into a downstream or side channel area. These structures would prevent the overtopping of canals and facilities from storm water inflows, operational spills, or excessive waves.

Use of Excess Material from Canal Excavation

Most of the canals that would convey more than 300 cubic feet/second would generate more excavation than needed for fill for the access roads and adequate freeboard. This excess waste material could either be placed adjacent to the canals or used for construction of habitat features, such as islands, in the Saline Habitat Complex. For example, an 18 mile long canal to convey 300 cubic feet/second of flows from the New and Alamo rivers to the vicinity of Salton City would generate about 3,600,000 cubic yards more excavation than fill. This material could be used to construct 60 islands, each about 2 acres in size with 10:1 slopes in 10 feet of water. Alternatively, the waste material could be used to construct over 130 peninsulas, each about 1500 long with 15:1 slopes. This would add over 70 miles of shoreline habitat. Many other configurations for adding new habitat are possible.

The cost estimates assume that all the waste material is used to construct shoreline habitat features when the excavated canal would be within 4 miles of Saline Habitat Complex areas. The remainder of the material would be wasted adjacent to the canal or conveyed to the Brine Sink.

Specific Canal Design Considerations

For each alternative, the canals would serve specific purposes, including Air Quality Management Canals, Saline Habitat Complex distribution canals, Pupfish Channels, Saltwater Conveyance canals, and Marine Sea Recirculation canals. In addition to the excavated canals, other features would serve similar conveyance purposes but are constructed differently. The Shoreline Waterway and Marine Sea Mixing Zone are examples of these other types of conveyance features that are described in following sections of this appendix.

Air Quality Management Canals

Air Quality Management Canals would be constructed and operated to supply freshwater inflows to Exposed Playa that would require water based mitigation measures, as described in Appendix H-3. For the PEIR, it was assumed that water efficient vegetation and brine stabilization would be used to provide dust control. The Air Quality Management Canals would convey water to the areas with water efficient vegetation. It is unclear where these emissive areas may be located; therefore, canal conveyance capacities were conservatively estimated to supply Air Quality Management areas anywhere within the Sea Bed.

Source water for the Air Quality Management Canals would be captured from the major inflow sources on the New, Alamo, and/or Whitewater rivers. The canals would start at a Sedimentation/Distribution Basin headworks facility. The canals would flow primarily by gravity along the upper contours of the shoreline to exposed areas downslope of the canal. For emissive areas located above the canal alignment, water would be diverted and pumped to the upslope area.

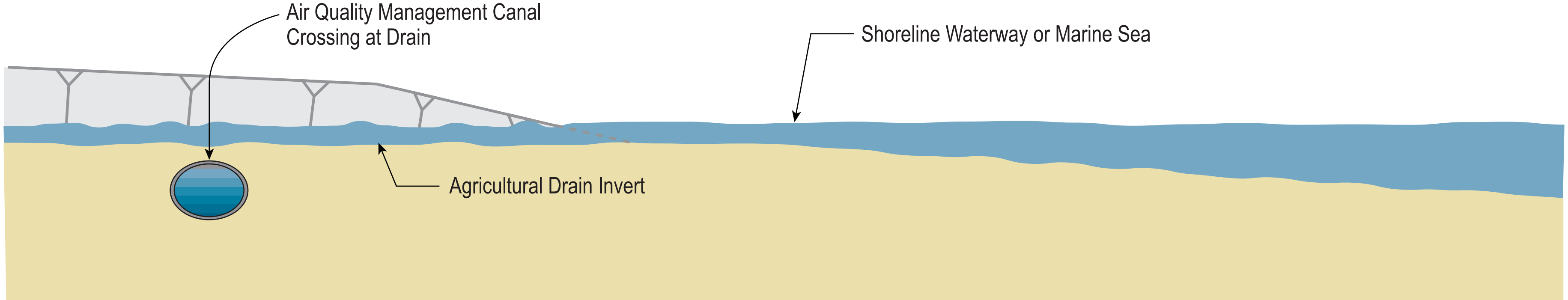
The SALSA model was used to calculate the Exposed Playa area and location. Water efficient vegetation was assumed for only a part of this area, as described in Appendix H-7. Canal sizes were calculated based on the peak flows to those areas. Since all deliveries would not be expected to occur at one time, it was assumed that no more than one fourth of the total Air Quality Management water efficient vegetation area on a canal segment would be irrigated at any given time.

Details of a typical Air Quality Management Canal are shown in Figures H6-3 and H6-4. This canal could convey up to 200 cubic feet/second. The unlined canal would be constructed with 2:1 side slopes and access roads on both sides. A wider access road would be provided on the downgradient side to increase access needed for the Air Quality Management areas. Canal water depths would be at least 5 feet deep. The bottom width of each canal would be a minimum of 6 feet. The canal surface would be about 30 feet across for most canal sections. Maximum velocities in the canal would be less than 1.5 feet/second.

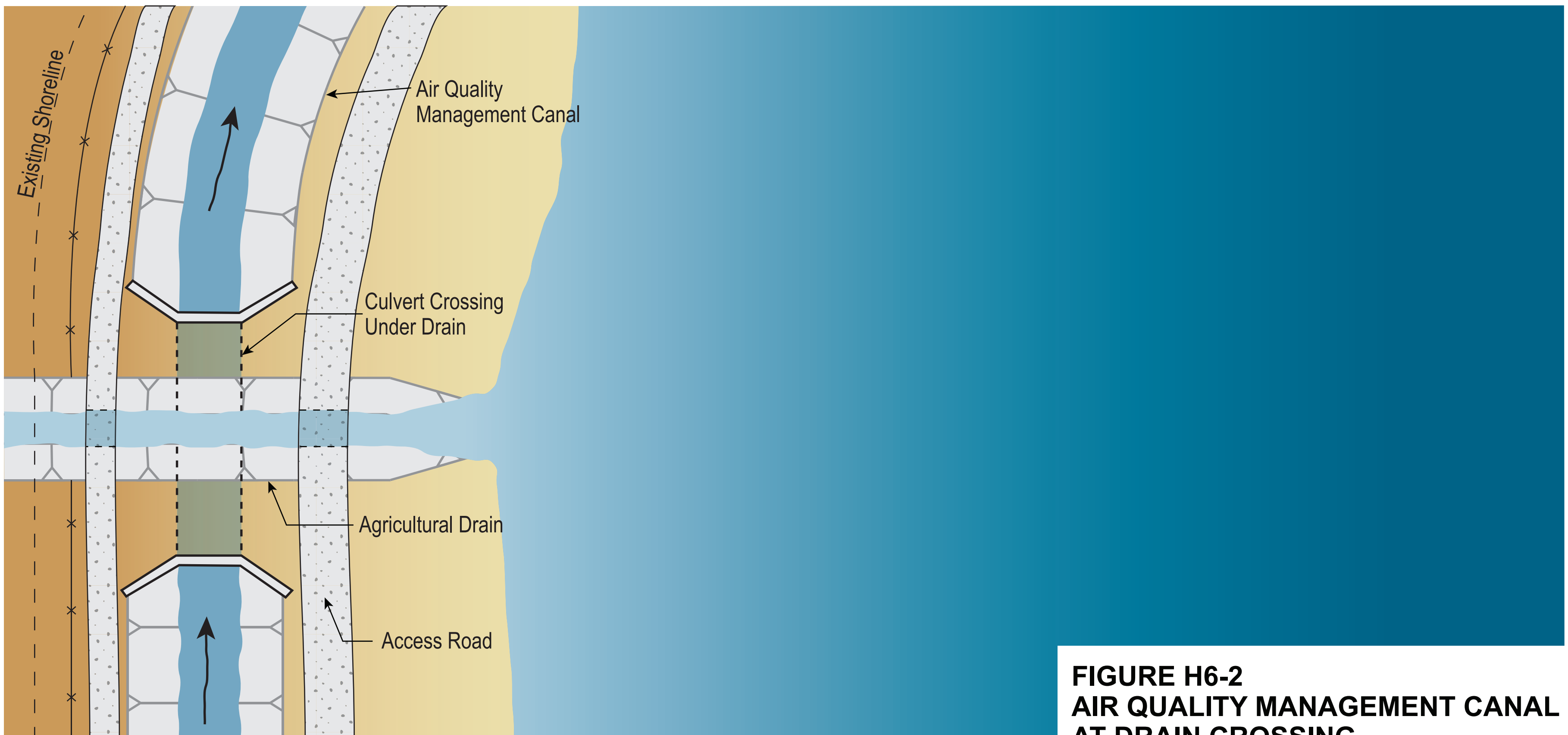
Some Air Quality Management Canals would be over 30 miles in length and gravity would be insufficient for the movement of water in a reasonably sized canal. Canal pumping plants are anticipated in many alternatives since there is insufficient hydraulic grade along the upper contours. The lift stations would be designed to lift the canal water surface from a lower contour to an upper contour. Location of these pumping plants would be determined in project-level analyses.

Saline Habitat Complex Distribution Canals

Saline Habitat Complex distribution canals would be used if Shoreline Waterways are not present to deliver desilted river inflow water to Saline Habitat Complex cells. The distribution of water into these canals would originate in a Sedimentation/Distribution Basin. The water would spill into a series of cascading ponds adjacent to the Saline Habitat Complex cells. From each of these ponds, water would flow into an open canal section aligned along a contour. Water levels would be maintained in the canal by an end-of-canal overflow control weir or similar structure. As needed, the Saline Habitat Complex distribution canal would convey water into each Saline Habitat Complex area through a turnout along the canal. Excess canal flows would flow over an end control weir. Inflows to these canals would be regulated from the Sedimentation/Distribution Basin headworks.



Profile View



Plan View

FIGURE H6-2
AIR QUALITY MANAGEMENT CANAL
AT DRAIN CROSSING

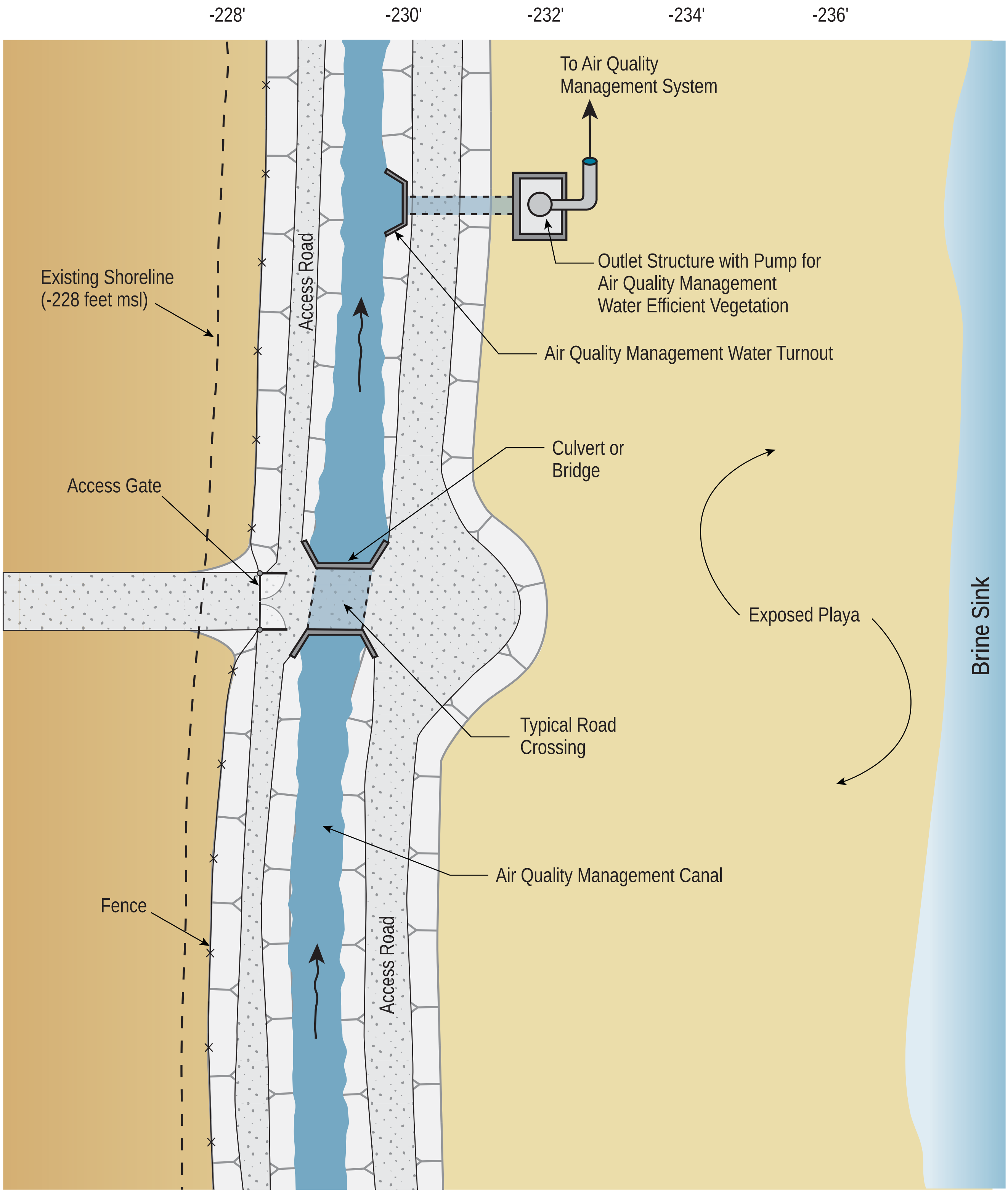


FIGURE H6-3
AIR QUALITY MANAGEMENT CANAL PLAN

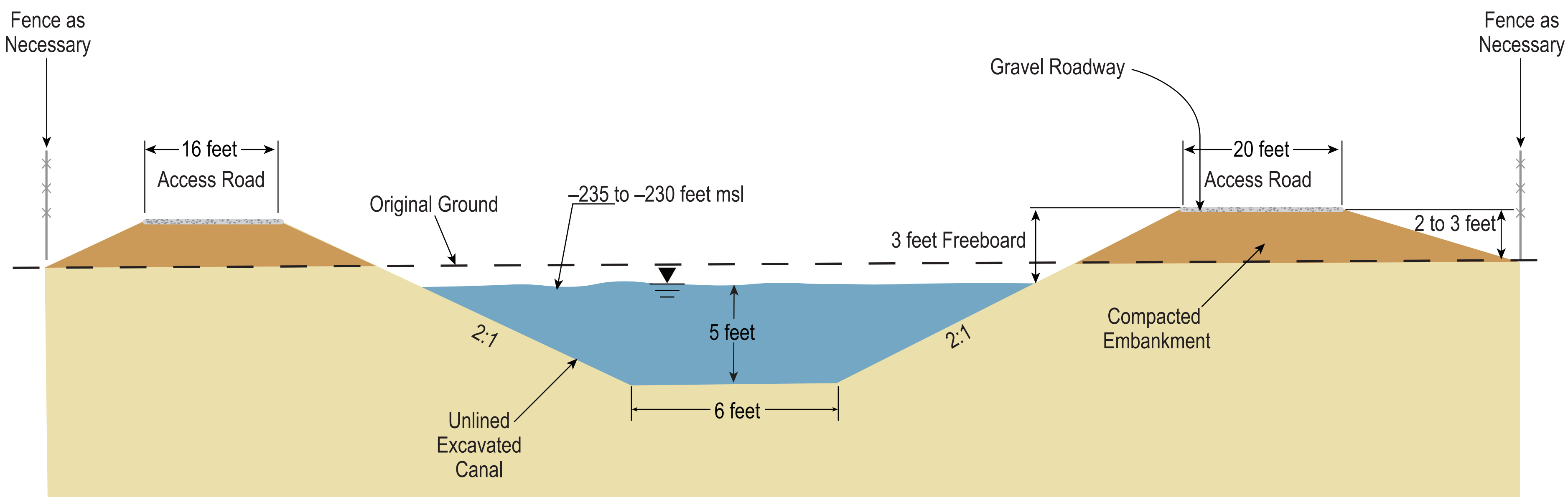


FIGURE H6-4
TYPICAL AIR QUALITY MANAGEMENT CANAL

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Saline Habitat Complex distribution canals also would capture the runoff from the Saline Habitat Complex areas upgradient from the canals. The saline water runoff from those cells would increase the Saline Habitat Complex distribution canal salinity.

The Saline Habitat Complex distribution canals would be constructed as the water recedes and additional Saline Habitat Complex areas are constructed. Water would not flow into these canals until the Saline Habitat Complex areas below the canal are completed.

A typical Saline Habitat Complex distribution canal would be an excavated and unlined open canal with 2:1 side slopes similar in cross section to an Air Quality Management Canal. A minimum bottom width of 6 feet would be desirable for constructability and to provide some storage capacity in the zero gradient canals. Canal velocities would be less than 1 feet/second.

Saltwater Conveyance Canals

Saltwater can be conveyed through canals, as well as through pipelines, ponds, pumps, and groundwater wells. As described earlier, blending salt with fresher inflow water could be used to create a range of saline habitats. The saltwater would generally need to be lifted through pumps and pipelines segments. To limit the pumping and pipeline lengths to short sections, deep canal sections could be dredged to the Brine Sink with pumping plants located in accessible areas away from the Brine Sink. Canals also could be used to collect the tailwater from each Saline Habitat Complex area.

Water depths in saltwater canals could be up to 10 feet deep or more if dredged from the Brine Sink, or as shallow as three feet if used to collect small amounts of tailwater from the Saline Habitat Complex. Construction methods would depend on the soil conditions and locations. For the PEIR, canal excavations were assumed to be constructed in moist or wet soils. Low ground pressure excavators or dredges could be used.

Pupfish Channels

Pupfish Channels are provided in some alternatives when there is no hydraulic connection between agricultural drains or when the only connectivity is a Brine Sink with salinity over 90,000 mg/L. Pupfish Channels would be drain interceptors that would be located perpendicular to and below the direct drains along the shoreline. All drain flows intercepted by this channel would be conveyed in this common drain. The Pupfish Channel would provide the necessary connection for desert pupfish to move freely between drains. However, Pupfish Channels would not cross rivers, so connectivity between all direct drains or inflows that support desert pupfish would not be connected.

The Pupfish Channel would be designed to minimize backwater effects on upstream drains by placing the Pupfish Channel water surface elevation below -228 feet msl. Water would be held in this channel by a drain overflow weir at one or both ends of the canal. Drain overflow weirs would not have fish screens, so diversion of fish over the weir could be possible. Depending on the alternative, drain inflow water would leave the Pupfish Channels and flow into the Saline Habitat Complex, the Brine Sink, or other area not intended to support desert pupfish.

Pupfish Channels would convey peak drain flows at maximum channel velocities of less than 1 feet/second. The Pupfish Channel would have a zero gradient invert so the channel could flow either way depending on the configuration of the overflow weirs. Drain flows could be quite variable throughout the year and could decrease to extremely low flows in some months depending upon agricultural activities.

The unlined Pupfish Channels would be constructed with 2:1 side slopes, as shown in Figure H6-5. The channels would be constructed to provide a minimum water depth of 5 feet with at least 3 feet of freeboard above the water level. A water depth of 5 feet would minimize the potential for encroachment of cattails and wading birds in the middle of the channel and possibly reduce the frequency of vegetation and silt management. The deeper section would be less likely to become dry during low drain flow periods.

Pupfish Channels would be constructed and operational prior to the drains becoming isolated. Existing drains that are currently pumped into the Salton Sea would also be connected in a gravity fed Pupfish Channel system.

These channels would be constructed by conventional excavation equipment from dry ground. Excavated soils are expected to be moist or wet since the canal invert would be below the existing drain inverts.

Marine Sea Recirculation Canal

The Marine Sea Recirculation Canals would be designed to circulate water from the Marine Sea areas in the northern and southern Sea Bed. This would be necessary for relatively small water bodies that could become too fresh if there were no blending with marine water. This circulation and blending would maintain salinities of at least 20,000 mg/L in the water bodies along the southern shoreline.

The Marine Sea Recirculation Canals would convey water with salinities of 30,000 to 40,000 mg/L at velocities of up to 2 feet/second during peak flows. The canals would be unlined canals excavated below the existing ground surface. Water surface elevations in the canal would be lower than the Marine Sea to provide gravity flow. A pumping plant near the downstream end of the canal would be designed to lift the water into the southern water body.

Several canal cross sections are possible to convey this flow, but for estimating purposes, an unlined canal with water depths up to 15 feet deep was chosen. Canal side slopes would be 2:1 with a minimum bottom width of at least 26 feet. Freeboard in this canal would be at least 5 feet deep. The canal water surface would be about 100 feet wide. Access roads would be provided on each side of the canal. A typical cross section of this canal is shown in Figure H6-6. A low lift pumping plant would be located near the downstream end of the canal. The exact location and size of facilities would be investigated in project-level analyses.

In Alternative 5, water would be conveyed from the New and Alamo rivers to the North Sea in a large open canal that would convey both Marine Sea water and Air Quality Management water. This canal would be similar in size and cross section to the Marine Sea Recirculation Canals.

Pipelines

In general, infrastructure layouts avoided use of pipelines where possible. Short sections of pipelines would be required at the pumping plants or where pressurized flow is necessary, such as at a canal undercrossings. Pipelines are considered to be significantly more expensive than canals, both in terms of capital costs and operations and maintenance requirements. Pipelines also require more hydraulic head to operate than canals and pose potential problems with corrosion and fouling from saline water.

Where pressurized flow would be necessary, it was assumed that the pipelines would be sized for flow velocities up to five feet/second. The Manning's formula was used with an "n" value of 0.013 to compute the head loss in the pipe. Minor losses were assumed to be 2 velocity heads/mile. Special considerations for corrosion and fouling are discussed in later portions of this appendix.

River Bypass Pipelines

River Bypass pipelines would be used when the extensions of the rivers must cross under a Shoreline Waterway, a Concentric Ring, Concentric Lake, or other canals, or when fresher inflows need to be conveyed to lower areas in the Sea Bed without being mixed with other water bodies.

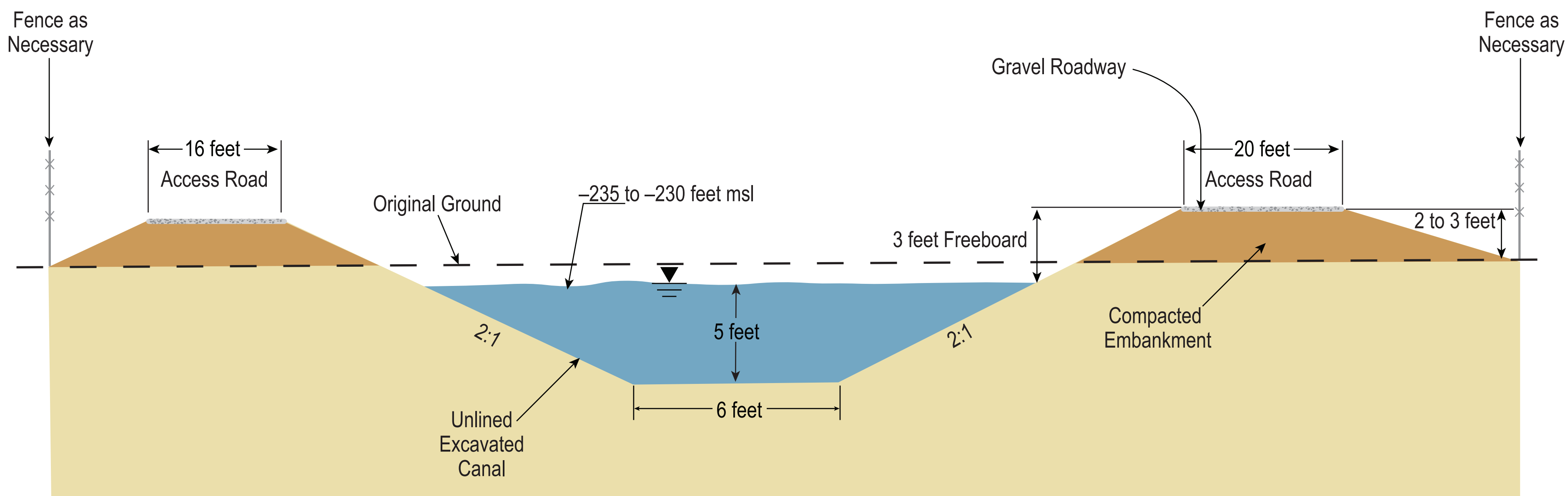

FIGURE H6-5
TYPICAL PUPFISH CHANNEL

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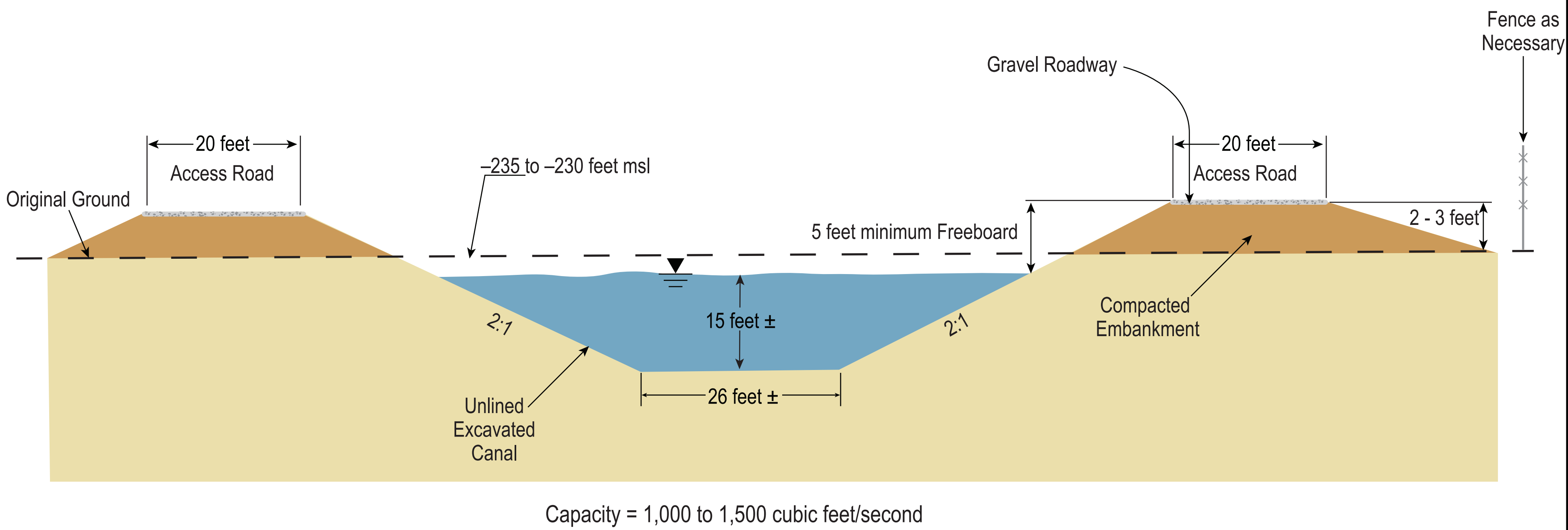

FIGURE H6-6
TYPICAL MARINE SEA RECIRCULATION CANAL OR NORTH SEA CONVEYANCE

Bypass pipelines would require a controlled intake and outlet facility. The intake facility must have the ability to completely close down the pipeline if necessary or regulate flows. The outlet facility must be designed with erosion controls at the outfall and regulation of flows for other water uses.

To prevent the unintended spills of inflow water into other water bodies, the bypass pipelines would be designed to convey the 99^{th} percentile of existing inflows from each river through each pipeline. This would allow for reliable salinity control in the Shoreline Waterway or Concentric Rings/Lakes.

These bypass pipelines would be designed as reinforced concrete pipes capable of withstanding the design loads upon it and resisting the uplift forces resulting from an empty pipe section. The pipes would be laid in dredged sections and backfilled with rock and other backfill to weigh it down. Pipelines would be limited to 42-inch diameter to reduce the pipe uplift. Therefore, if necessary, several pipelines are assumed in the alternatives. The pipelines are assumed to be filled with water at all times through a downstream control structure.

Saltwater Conveyance (Pipelines)

As previously described, it would be more advantageous to convey saltwater in canals. However, pipelines would be required in areas downstream of pumping plants. Conveying concentrated saltwater solutions and brines would be limited to short and oversized pipeline segments.

To reduce brine and other chemical deposits, brine solutions with salinities over 200,000 mg/L would be diluted with fresher inflows to reduce salinity. Pipeline materials would be limited to corrosion and fouling resistant materials, such as titanium and various polyethylene materials.

Pumping Plants

Due to the relatively flat terrain at the Sea Bed and shoreline and the long distances that water would need to be conveyed, many of the alternatives would require pumping plants to lift water 5 to 20 feet. Each pumping plant would have vertical turbine pumps. The smallest pumping units would be part of the Air Quality Management areas and the largest pumping plants could have up to 1,200 cubic feet/second capacity for Saltwater Recirculation. Figures H6-7 and H6-8 show a conceptual pumping plant along an Air Quality Management Canal. Figures H6-9 and H6-10 show a conceptual large low lift pumping plant used to move water for recirculation or transport purposes. Redundant pumping units could be required depending upon operations and maintenance needs for each pump. As described under pipelines, pumping units should be limited as much as possible due to the corrosive and fouling environment and electrical costs. Pumping plants included in the components are summarized in Table H6-3.

Table H6-3
Pumping Plants in the Alternatives

Conveyance Facility or Component or Activity	Pumping Plants
Air Quality Management Canal	Canal lift stations
	Turnout facilities for water efficient vegetation
Air Quality Management Water Efficient Vegetation System	Filter units
	Pipelines and irrigation system
	Saltwater recirculation diversions
	Water blending
Air Quality Management Stabilized Brine	Saltwater recirculation diversions and pipelines
Air Quality Management - Temporary Irrigation	Temporary irrigation system
Marine Sea Recirculation Canal	Canal lift stations
Saltwater Conveyance	Canal lift stations
	Shallow groundwater wells
	Brine Sink diversion
	Saline Habitat Complex portable pumps
Concentric Rings	Recirculation pumping plants in rings
Water Treatment Plant	In-plant to maintain hydraulic grade, blend chemicals, backflush filters, and residual management
Construction Activities	Dewatering and dredging activities
	Dust control

Other Conveyance Systems

In addition to traditional canal and pipeline systems described above, some of the alternative specific infrastructures would include other facilities or features to transport water around the Sea. These facilities or features include Shoreline Waterways, Marine Sea Mixing Zone, and Saltwater Conveyance.

Shoreline Waterway

The Shoreline Waterway would be a shallow brackish water body used to blend and distribute water to the Saline Habitat Complex in many of the alternatives. Inflows to this water body could be from a variety of sources including drains, rivers, Marine Sea, Brine Sink, or saltwater conveyance systems. The Shoreline Waterways could provide desert pupfish connectivity if located along the shoreline. Target salinities in the Shoreline Waterway would be between 20,000 and 30,000 mg/L.

The Shoreline Waterway would be formed by a Berm or Perimeter Dike on one side and the existing shoreline or another Berm on the other side. Water depth in the Shoreline Waterway would be limited to 6 feet deep at the upgradient Berm or Perimeter Dike. The width of the Shoreline Waterway would be dependent on the contour of the Sea Bed, but could be as wide as 2 miles in some locations or as narrow as 0.25 mile. Flows through the Shoreline Waterway would be limited to what is needed by the Saline Habitat Complex.

Construction of either a Berm or Perimeter Dike along the Shoreline Waterway would depend on whether the Sea Bed is exposed or not. If the Sea Bed is exposed, construction of a compacted earthen Berm would be feasible. For purposes of cost estimates presented in Appendix H-7, construction of a Berm was assumed.

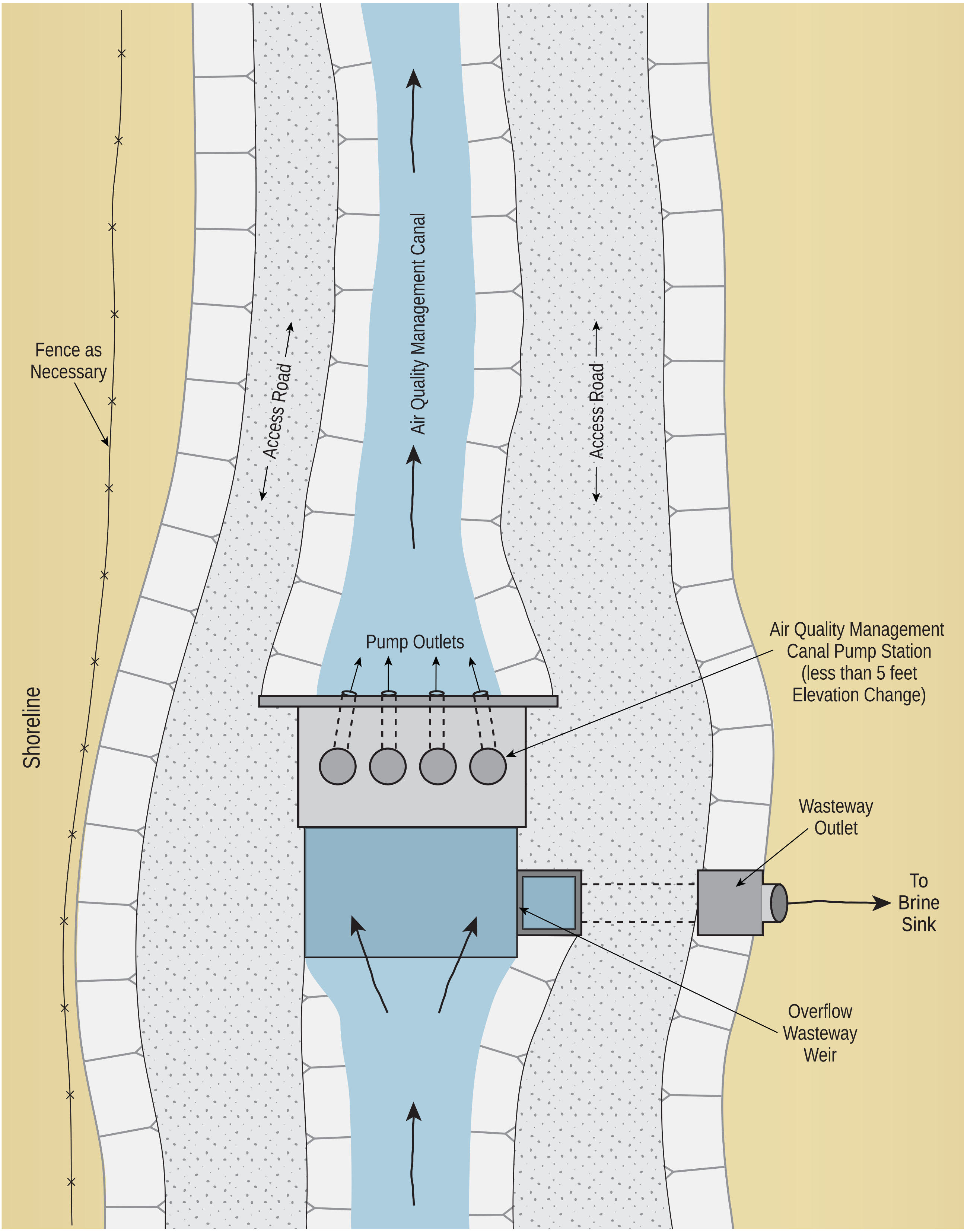

FIGURE H6-7
AIR QUALITY MANAGEMENT CANAL PUMPING PLANT PLAN

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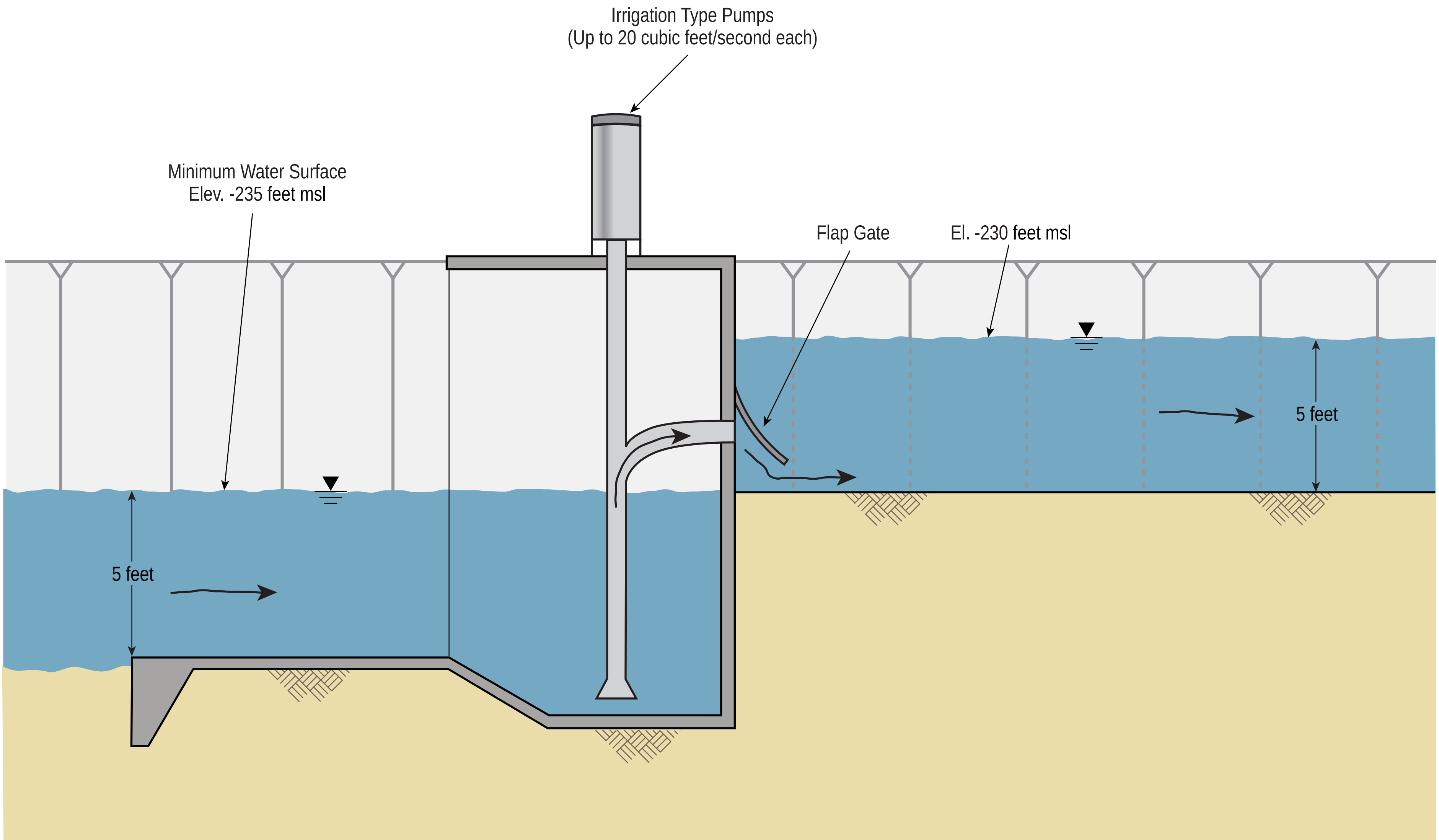
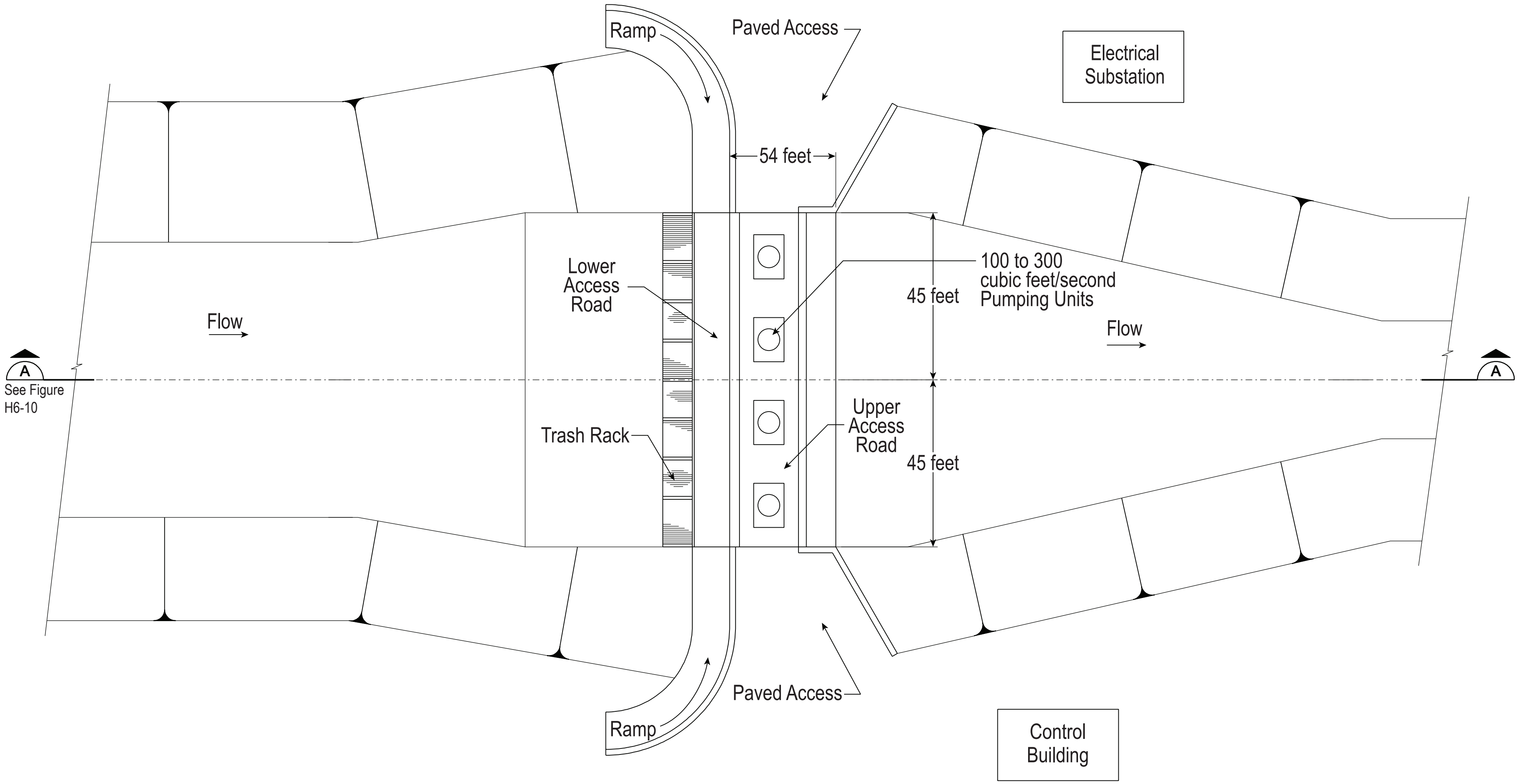


FIGURE H6-8
AIR QUALITY MANAGEMENT CANAL
PUMPING PLANT PROFILE



Notes:

1. Site plan shown for construction on marine sea recirculation canal.
2. Large pumping plant arrangements similar for recirculation pumps on Alternative 3 (400 cubic feet/second) and for Alternative 5 (1,200 cubic feet/second).
3. Not to Scale

FIGURE H6-9
TYPICAL PLAN LARGE LOW LIFT PUMPING PLANT FOR ALTERNATIVES 3, 5, 6, 7, AND 8

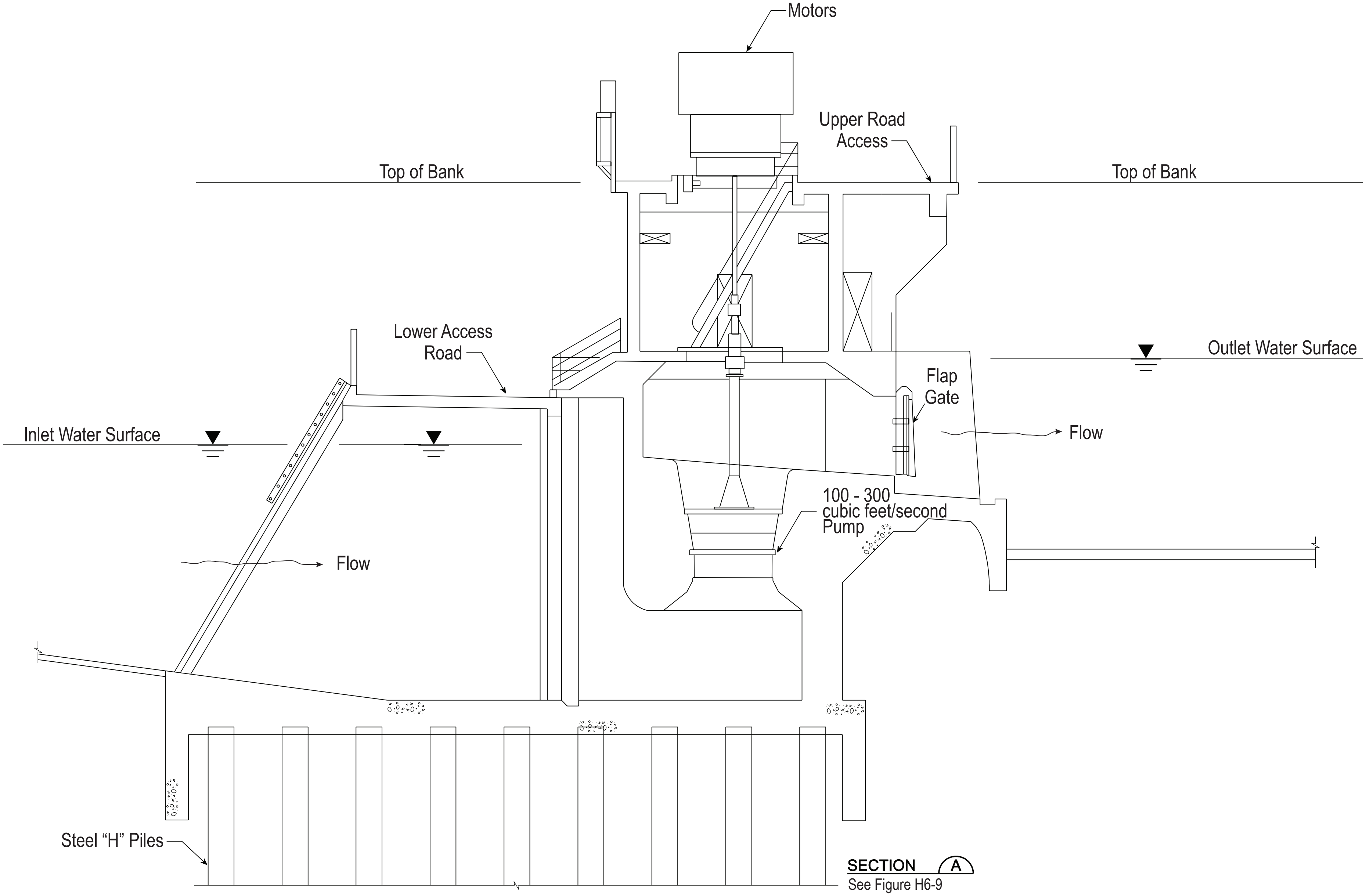


FIGURE H6-10
TYPICAL PROFILE LARGE LOW LIFT PUMPING PLANT FOR ALTERNATIVES 3, 5, 6, 7, AND 8

Note: Not to Scale

Marine Sea Mixing Zone

The Marine Sea Mixing Zone would be located along the western shoreline in Alternatives 6 and 7 (referred to as a Recreational Estuary Lake in Alternative 7). That portion of the Marine Sea under Alternative 8 along the western shoreline would be constructed in the same manner as the Marine Sea Mixing Zone, however the salinities would be greater than 30,000 mg/L. A Marine Sea Mixing Zone would be bound by the shoreline on one side and a Perimeter Dike on the other. This waterbody would be a wide conveyance channel similar to the Marine Sea Recirculation Canal on the eastern shoreline. Salinities in this Marine Sea Mixing Zone would be between 20,000 and 35,000 mg/L. Water depths would be up to 15 feet deep. The flow would be up to 2,000 cubic feet/second to accommodate the combined inflows from the New and Alamo rivers in the initial years of operations. The width of the Marine Sea Mixing Zone would be based on the locations of contours, and could be as wide as 5 miles in some locations or as narrow as 0.25 mile.

Saltwater Conveyance in Ponded Areas

Saltwater conveyance channels would move water between ponded areas, such as in the Saline Habitat Complex cells. The saltwater conveyance channels would be created between two Berms that form the Saline Habitat Complex cells. Excavating a channel between the Berms would not be necessary, but may facilitate conveyance or increase water depth. If a channel is constructed, the excavation must be sufficiently away from the toe of the Berm to avoid stability issues. Because the Berms would have side slopes of at least 3:1, and the depth between the upstream and downstream Berms would differ by 6 feet, the water surface width would vary from about 90 feet to 30 feet if the Berms were 30 feet apart at the bases.

Flows through the saltwater conveyances could be up to 20 cubic feet/second, depending on saltwater salinity and inflow quantity needed to mix with the water in the Saline Habitat Complex cells.

SALINE HABITAT COMPLEX

The Saline Habitat Complex would consist of independently managed saline water bodies of up to 1,000 acres/cell created for habitat management. As described in Appendix H-1, Saline Habitat Complex cells would be managed and operated as deeper saline open water bodies (Type 1), or as shallower managed saline water bodies (Types 2 and 3). Water would be conveyed to and through these water bodies to create the desired salinity and water depths. Water would be supplied to each cell in one of the following methods:

- Shoreline Waterway (which includes inflows from Saltwater Conveyance system);
- Direct drains or Pupfish Channel;
- Saltwater conveyance; and
- Discharge from adjacent Saline Habitat Complex cells.

Flow into and out of each Saline Habitat Complex cell would be managed for both salinity and water depth by a set of control gates and weirs on the containment Berms. Controlling water residence time in each cell could allow each cell to reach desired salinity targets. To meet minimum salinity targets, water must enter the cell at the target salinity, or the inflow water must be evaporated in the cell to reach the target salinity. Higher salinity targets would require longer residence times. Salinity would be controlled by discharging more saline flows from each cell to maintain the salt balance.

In alternatives without Shoreline Waterways adjacent to the Saline Habitat Complex, each cell would be managed independently of other cells. Using the evaporation method, inflows with salinities of 3,000 to 7,000 mg/L would be concentrated to higher salinities by limiting outflow rates. Pumping saline water initially into these cells with a portable pumping system could reduce the period of time that a cell would function at lower salinities during the start-up process. Once the desired salinity is obtained in a cell, outflows would be managed to maintain the target salinity. The discharged water could become a salt supply for other cells.

In alternatives with Saline Habitat Complex and Shoreline Waterways, conveyance into the cells would be through a common Shoreline Waterway distribution system. Inflows to the Shoreline Waterway would be from the Sedimentation/Distribution Basin and, if possible, from the direct agricultural drains. These inflows would be blended with saltwater from the saltwater conveyance system to achieve a blended salinity of at least 20,000 mg/L. The quantity of inflow to the Shoreline Waterway would be regulated to meet the Saline Habitat Complex water demand. In this arrangement, flows would enter the first tier of Saline Habitat Complex cells from the Shoreline Waterway. Flows from the first tier of cells would flow into the next tier of cells. Flow rates through the first tier cells would be about two times more than would be needed in these first cells. The flows would be designed to meet water demands in the first cells and all of the downgradient cells. As third and fourth tier cells are constructed, flow rates through the upper cells would increase. In this arrangement, salinity would always be lowest in the upper cells and highest in the lower cells. These tiered cell systems would be managed primarily from the Shoreline Waterway inflows. Water control gates within each cell would regulate circulation, depths, and possible salinity variations. A water demand for the Saline Habitat Complex would be about 7.2 acre-feet/year/acre.

SEDIMENTATION/DISTRIBUTION BASINS

Sediment carried by the inflows currently settles out in the Salton Sea near the confluences of the rivers and creeks. Future conveyance facilities could become clogged with sediment. The Sedimentation/Distribution Basins would capture sediment and control inflows for distribution to the various components. As described above, the Sedimentation/Distribution Basins would be placed within the existing Sea Bed as much as possible to avoid existing drainage impacts and interference with agricultural operations. Each basin would be designed to keep the ponded water surface elevation at or below -228 feet msl.

Sizing

The Federal-State Reconnaissance Report (DOI, 1969) estimated, from empirical relationships with other reservoirs, that the future long term average sediment inflow to the Salton Sea would be 4,000 acre-feet/year. However, based on Imperial Irrigation District (IID) data from 1952 to 1969, the reconnaissance report estimated that the New and Alamo rivers conveyed 340 and 370 acre-feet/year of sediment, respectively, for a total of about 710 acre-feet/year.

The Desiltation Basin Demonstration Project on the Peach Drain in IID provided sediment data on one IID drain (Remington, 1996). The Peach Drain collects drainage water from about 3,000 acres of farmland and has an average flow of 15 cubic feet/second. In about 11 months from the fall of 1993 to the fall of 1994, about 2 acre-feet (3,170 cubic yards) of sediment was collected and removed from the 0.25 acre desiltation basin. The basin provided a detention time of about 15 minutes. Measurements of suspended sediment upstream from the basin from September 8, 1993 through August 31, 1994 averaged about 270 mg/L. At an average flow of 15 cubic feet/second, and an allowance of 10 percent additional sediment in the bed load, the total sediment in the flow for this period was about 2.9 acre-feet. If scaled to the entire IID area, this would yield about 480 acre-feet of sediment from New and Alamo rivers.

Reclamation and USGS also collected significant data on potential sediment inflow loads and made predictions based on both historical and projected inflow levels (Reclamation, 2005).

The Final Environmental Impact Report/Environmental Impact Statement for the Water Conservation and Transfer Project (IID and Reclamation, 2002) used IID sediment data from 1969 to 1998. Flow-weighted average sediment concentrations in the New River were 313 mg/L with an average flow of 622 cubic feet/second. Flow-weighted average sediment concentrations in the Alamo River were 479 mg/L with an average flow of 843 cubic feet/second. These values were used to calculate a sediment load of about 387 acre-feet/year (126 acre-feet/year from the New River and 261 acre-feet/year from the Alamo River).

If the basin was 10 feet deep or less, most of the sand and silt in the water would settle out within a day. Assuming a maximum inflow of 1,200 cubic feet/second from the Alamo River, a basin about 240 acres and 10 feet deep would provide one-day detention time. Assuming a maximum inflow of 860 cubic feet/second from the New River, a basin about 170 acres and 10 feet deep would provide one-day detention time. This size basin would likely need maintenance to remove sediment every few years. Larger basins would provide for sediment accumulation over longer periods of time and would remove smaller and lighter sediment particles. Basins of one square mile in size for each river would provide about three days of detention time. However, larger basins may not be as efficient because they could be more subject to mixing by wind and that could resuspend the sediments.

While historical or recent information is useful, it may not be a good indicator of future sediment loads. As described in Chapter 6, Total Maximum Daily Loads (TMDLs) for sediment have been implemented in the Imperial and Coachella valleys and would reduce sediment loading. For purposes of this PEIR, the sediment loads projected by the Colorado River Basin Regional Water Quality Control Board (CRBRWQCB) were assumed for all inflows. Sedimentation/Distribution Basins for all three rivers were sized at 200 acres each. Each basin would be no deeper than 6 feet with a uniform bottom grade to reduce maintenance and improve silt settling. However, specific studies would need to be completed as part of project-level analyses to determine final sizes.

Periodic sediment removal would be expected to occur every other year in each basin. The silts would be expected to be dredged and conveyed to the Brine Sink for disposal. Alternatively, the dredged spoils could be used for the creation of islands in the Saline Habitat Complex area.

Several Sedimentation/Distribution Basins layouts are shown on Figures H6-11 through H6-14. Features of these basins are conceptually shown to indicate design concepts. Other configurations are also possible.

The Sedimentation/Distribution Basin may include levees, decanting weirs, overflow structures, river bypass outlets, Air Quality Management Canal outlets, Shoreline Waterway outlets, and radial gates for outlet facilities. The outlet control structures for many of the facilities in the PEIR alternatives have been assumed to be constructed of reinforced concrete with control gates (side gates or radial arm gates), remote operations and monitoring capabilities, labyrinth weirs or broad crested spillways, and foundation supports.

Sedimentation/Distribution Basins would be constructed early in Phase I to provide flows to components as they are constructed.

Overflow Spillways

As mentioned above, it is not practical to size the canals to convey peak flows into the components. Spillways would allow passing high flows and excess flows to the Brine Sink. The size of the spillway would depend on the acceptable risk to potential failure of facilities due to overtopping during extreme flow events.

For the PEIR, it was assumed that spillways for the Sedimentation/Distribution Basins would be sized 20 percent greater than the maximum daily flow recorded. This would require spillways to convey 3,600 cubic feet/second for the New River, 5,400 cubic feet/second for the Alamo River, and 3,000 cubic feet/second for the Whitewater River. The alternatives in the PEIR include a labyrinth weir configuration with 3 feet of hydraulic head and a weir length about 1.75 times the structure width. This configuration would require structure widths of 180 feet for the Alamo River, 120 feet for the New River and 100 feet for the Whitewater River. More detailed flow frequency analysis would be required in project-level analyses before final sizing of the spillways.

Outlets/Spillways

Depending on the alternative, outlets could be used to deliver water from the Sedimentation/Distribution Basin to Exposed Playa of the Sea Bed or Air Quality Management areas. Sluiceways also could be used to convey excess flow to the Brine Sink and remove sediment from the Sedimentation/Distribution Basin.

BARRIERS, PERIMETER DIKES, AND BERMS

There are five general types of water retaining embankments in the alternatives:

- Barrier Type 1: Rockfill Barrier, or dam, with upstream seepage blanket constructed on the existing Sea Bed without excavated foundation (used in Alternatives 5, 6, and 8);
- Barrier Type 2: Rockfill Barrier, or dam, with internal seepage blanket constructed with an excavated foundation (used in Alternative 7);
- Perimeter Dikes: lower height versions of Barrier Types 1 and 2;
- Berms: constructed of excavated soils from the Sea Bed; and
- Geotube® Berms: A variation of a Berm, but constructed using a dredge-filled geotextile tube and covered with excavated soils from the Sea Bed.

While each of these facilities would be designed to retain water, the facilities would use different construction methods, construction materials, design safety factor, and embankment quantities per unit length. For purposes of classifying the various types of embankments, the following terms were used:

- **Barriers (Types 1 and 2) –** Rockfill embankments retaining water over 20 feet deep. These embankments would be under the jurisdiction of the California Department of Water Resources, Division of Safety of Dams (DSOD);
- **Perimeter Dikes –** Rockfill embankments retaining water between 6 and 20 feet deep. Like Barriers, these embankments would be under the jurisdiction of DSOD.
- **Berms –** Compacted earthfill embankments holding back water 6 feet deep and less. These embankments would not be under the jurisdiction of DSOD. Berms could be constructed as compacted embankments similar to levees. Berms also could consist of soil filled Geotubes® (or elliptical shaped geotextile tubes) covered by earthfill materials.

Barriers and Perimeter Dikes

Rockfill Barriers and Perimeter Dikes would be placed across the Sea Bed to retain water in a similar manner to the way a dam blocks water in a canyon. Perimeter Dikes would be lower height Barriers constructed along contours that parallel the shoreline. The Barriers and Perimeter Dikes would be the most significant features of many of the alternatives. The Barriers could be between 8 and 12 miles long depending on location. Water depths behind the Barriers could be up to 55 feet deep. Perimeter Dikes would be up to 30 miles long with water depths up to 15 feet.

Two rockfill Barrier designs were considered in the PEIR. Type 1 would be a wide, uniform rockfill Barrier with a seepage blanket placed on the upstream face, as described in Appendix H-4, and would be used in Alternatives 5, 6, and 8. Type 2 was proposed by the Salton Sea Authority for Alternative 7 and would be constructed by excavating a trench up to 35 feet deep under the Barrier, and backfilling this area prior to placement of rockfill on top of that section. The seepage blanket in this design would be in the core of the Barrier. Removing the low-strength sea floor and soft lacustrine deposits under the Barrier

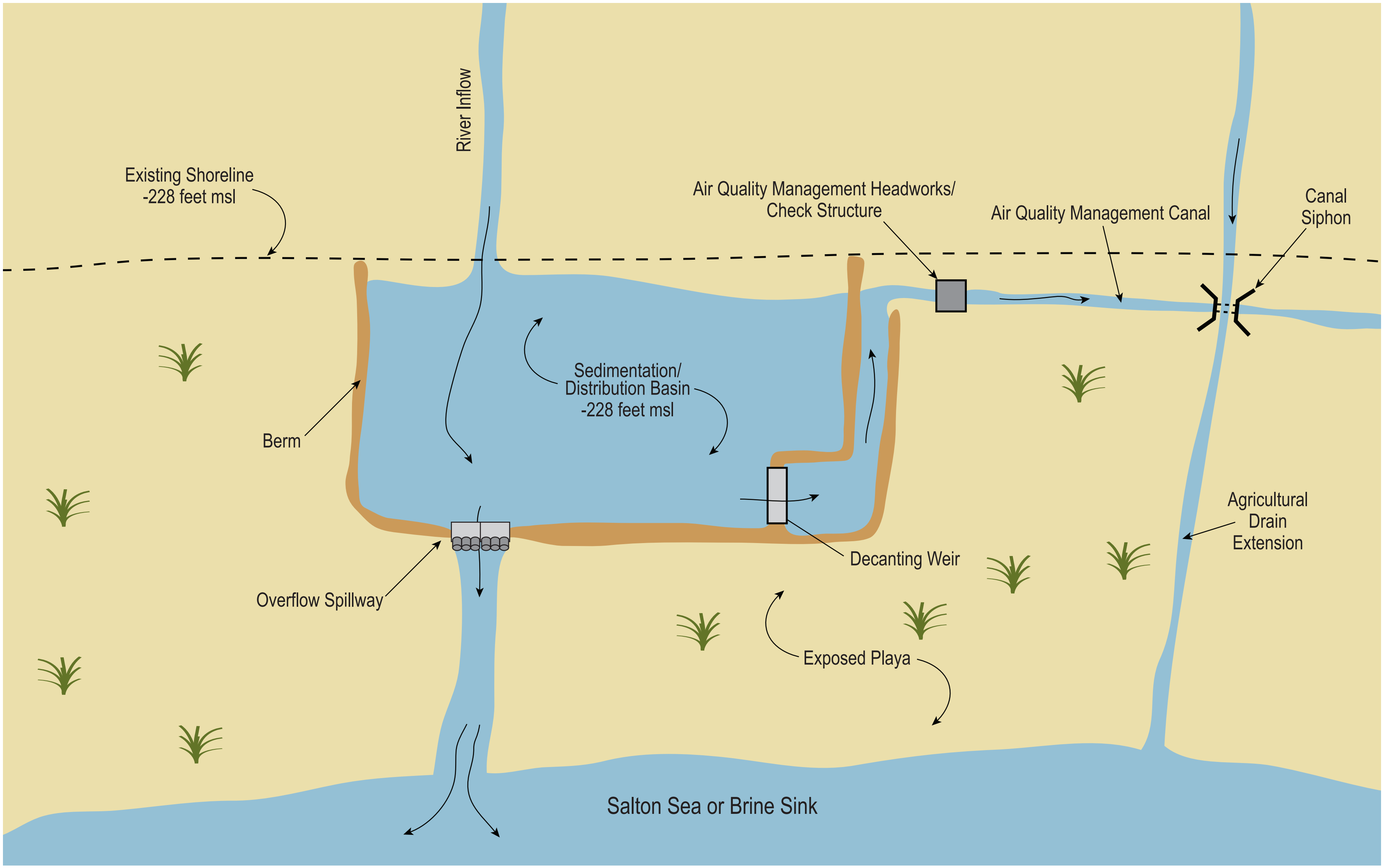


FIGURE H6-11
SEDIMENTATION/DISTRIBUTION BASIN FOR NO ACTION ALTERNATIVE AND ALTERNATIVE 1

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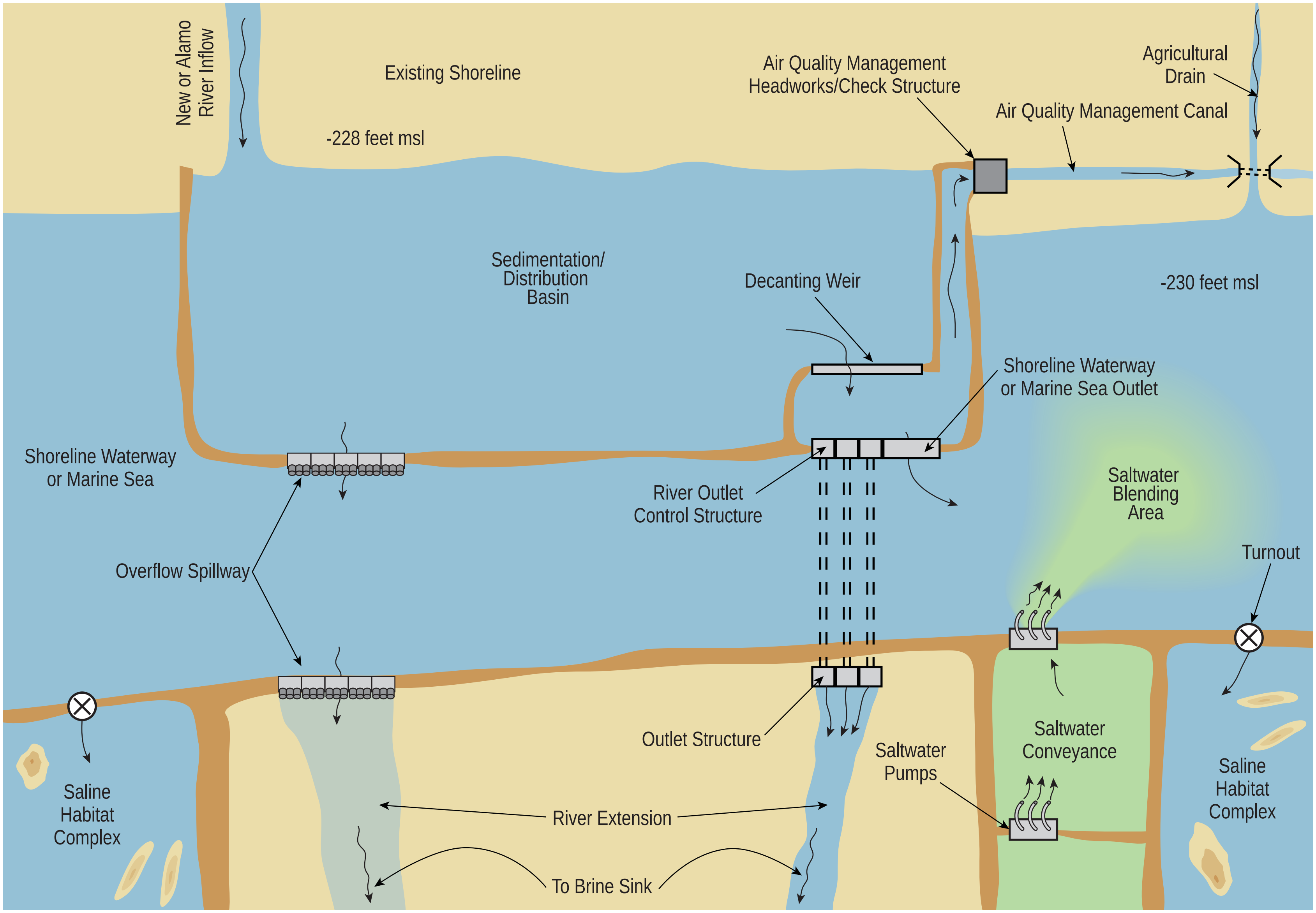

FIGURE H6-12
SEDIMENTATION/DISTRIBUTION BASIN FOR ALTERNATIVES 2, 3, 4, 5, AND 8

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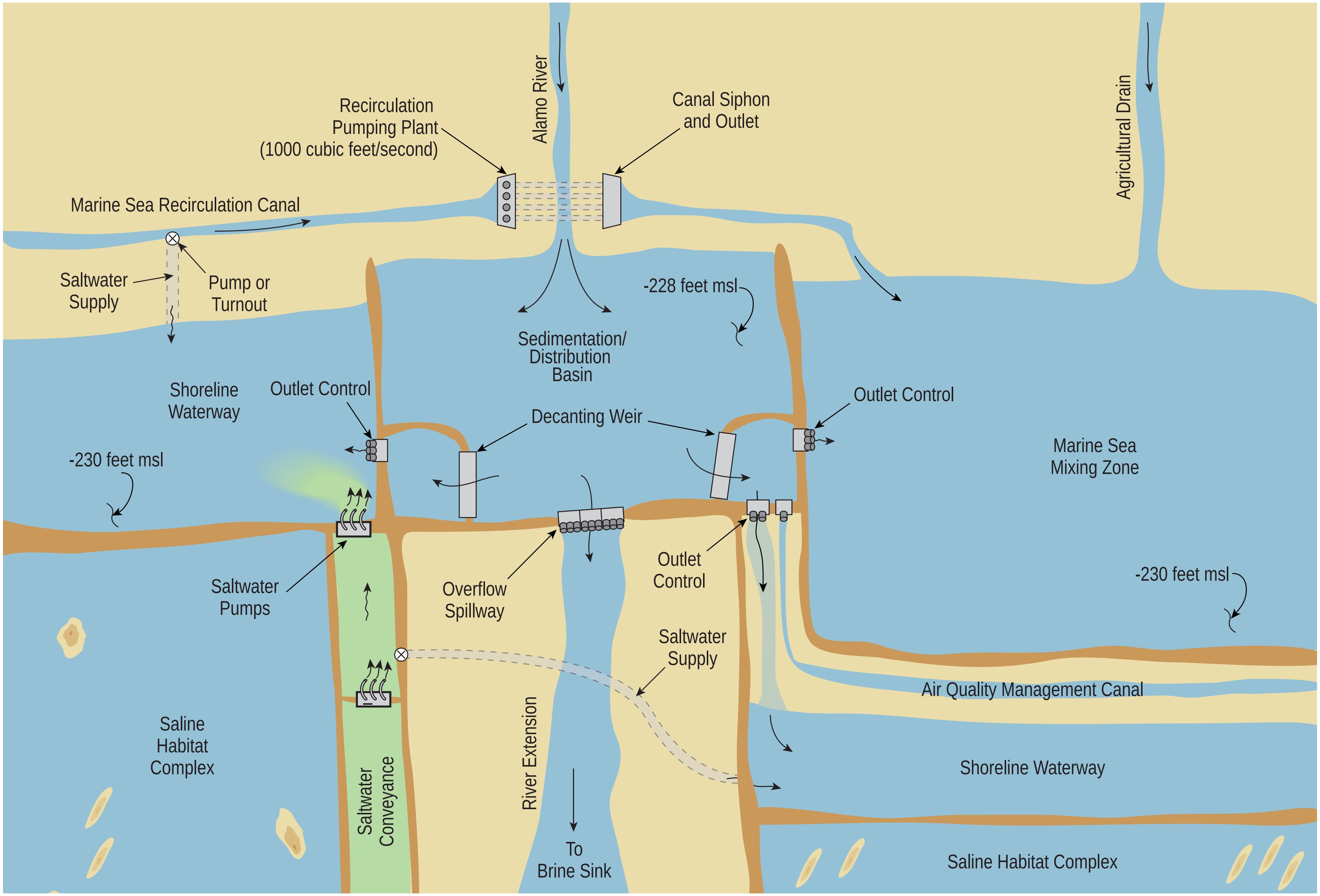

FIGURE H6-13
SEDIMENTATION/DISTRIBUTION BASIN FOR ALTERNATIVE 6

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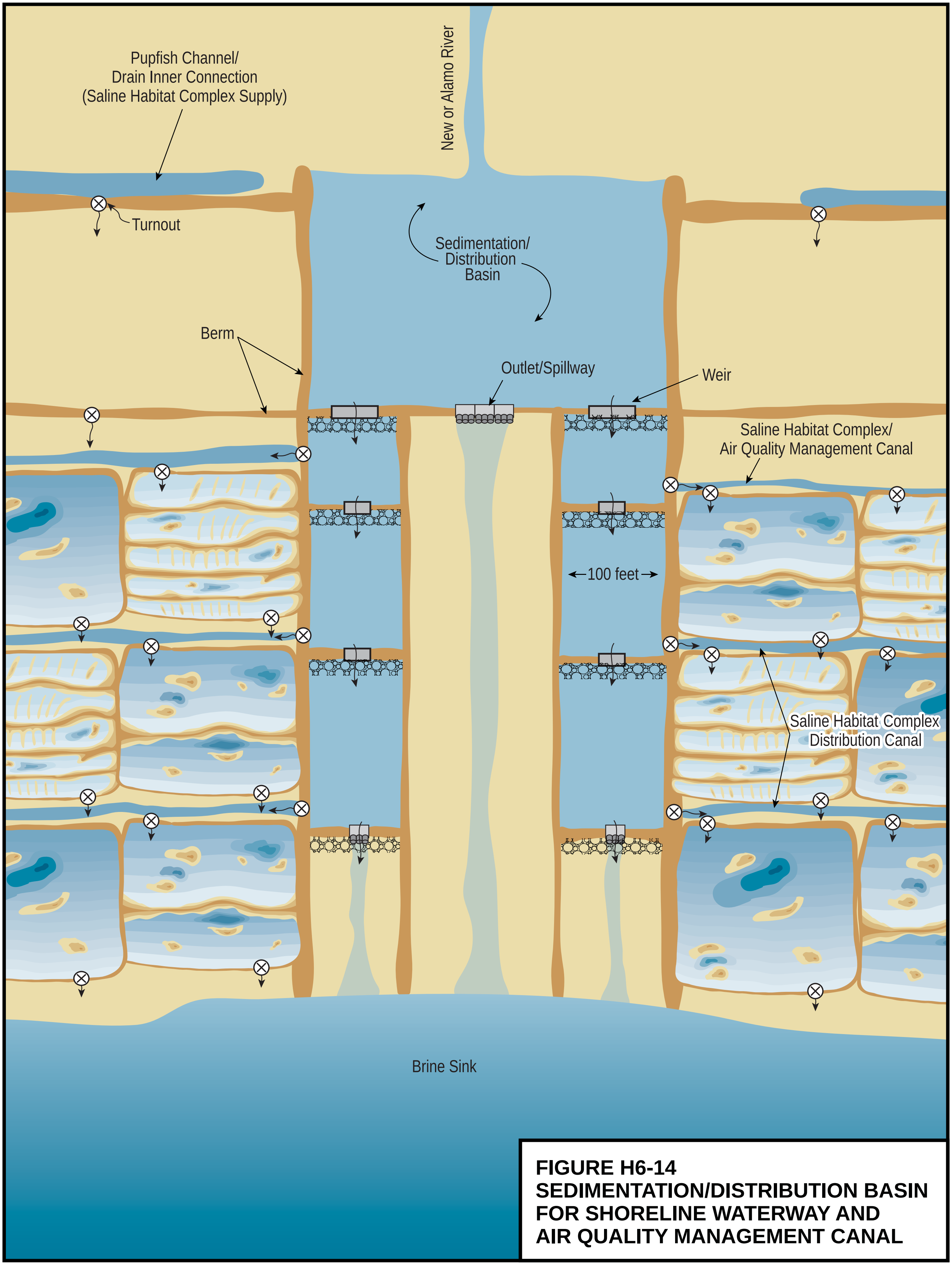

FIGURE H6-14
SEDIMENTATION/DISTRIBUTION BASIN FOR SHORELINE WATERWAY AND AIR QUALITY MANAGEMENT CANAL

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could provide the stability needed to support a Barrier with side slopes as steep as 3:1 upstream and 4:1 downstream. Details of both Barriers sections are described below.

Barriers and Perimeter Dikes would need to meet stringent design standards and seismic design criteria required by DSOD. The design, construction, and operations and maintenance reviews mandated by DSOD could be exempt if the federal government is responsible for construction. Then, the federal design standards would be utilized. The main design elements that must be considered include:

- Geologic setting;
- Division of Safety of Dams guidelines;
- Input ground motion;
- Seismic performance;
- Upstream and downstream slopes;
- Fault offset in foundation;
- Seepage potential;
- Liquefaction potential;
- Spoil disposal assumptions;
- Foundation objectives;
- Seismicity;
- Slope stability (static, seismic, and post earthquake);
- Material selection and rock quarry sources;
- Design flood and flood protection;
- Freeboard requirements;
- Constructability;
- Potential rock sources;
- Deformations;
- Settlement; and
- Operations and maintenance.

Limitations of Analysis and Next Steps

Designs for the Barriers, Perimeter Dikes, and Berms would require extensive geotechnical investigations along a preferred alignment. Most of the existing geotechnical foundation information was collected near the mid-sea location and may not be applicable to the final Barrier location.

Once geotechnical data is collected, the Barrier design concept would be refined. Small changes in cross sections or materials could significantly change rockfill quantities, excavation quantities, and costs. Similarly, foundation treatment, if required, could change costs and construction methods. Settlement assumptions also need site specific information.

For purposes of the PEIR, development of new rock sources or transportation facilities are not considered part of the alternatives and the impacts of developing new facilities would be evaluated in a separate evaluation. The alternatives assume that the Barrier and Perimeter Dike designs would use rock or boulders between 1 to 5 feet in diameter for the majority of the Barrier and Perimeter Dike materials. The current Barrier design, outlined in Appendix H-4, relies on this larger rock for stability in earthquake events. This sized rock was not located in large quantities at existing quarries during the preparation of this PEIR, as described in Appendix H-5. However, the alternatives assume that this rock would be provided from a permitted quarry and transported to within 10 miles of the shoreline by methods other than trucks.

Barrier and Perimeter Dike Design – Type 1

The basis of the conceptual Barrier/Perimeter Dike Type 1 design is presented in Appendix H-4. A key assumption of the design is that the Barrier/Perimeter Dike can be constructed in inundated areas using barges without excavating the foundation material. The rationale is that the Sea Bed is composed of low strength clay, and any attempt to excavate the material would simply expose more of the same material. Therefore, the design accounted for the settling of the foundation that would occur, and maintenance to restore the section as needed during the first few years of operation. Additionally, it has been found that the near surface Sea Bed deposits contain selenium, which if introduced into the food web, could lead to ecorisks. Therefore, efforts should be made to avoid disturbing these deposits during excavation or dredging; and, thereby, avoiding introduction of sequestered selenium into the water column.

The Barrier Type 1 cross section would be based on a design deformation of the structure of 0.5-foot vertically and 3-feet laterally during a major earthquake on the San Andreas Fault. The Barrier section would have an upstream slope of 10:1 and a downstream slope of 15:1, as shown in Figure H6-15. No top width would be needed, but a 20-foot maintenance road would be added on top of the Barrier cross section. The minimum freeboard of this Barrier would be 5 feet. The addition of the access road could add an additional 2 feet for a total of 7 feet of freeboard.

The Perimeter Dike cross section (Type 1) is similar to the Barrier Type 1 described above and is likewise designed to function with design deformations and have adequate factors of safety. The basic difference is that its overall height is lower, as shown in Figure H6-16. Construction methods could be different for the lower height Perimeter Dikes, because barge access could be limited.

The Type I concept would require a rockfill embankment with a maximum material size of 4 to 5-foot diameter for the portions of the Barrier over 25 feet in height, and rockfill of up to 3 feet in diameter for lower Barrier height sections or Perimeter Dikes.

The Type 1 Barrier/Perimeter Dike design with upstream seepage blanket would not cause a build up of pore pressures in the pervious dam core. High pore pressures can affect Barrier stability. However, too much seepage through a permeable dam could affect the water and salt balance if too much water seeps through the Barrier to the Brine Sink. In this case, the Marine Sea would become too fresh or it could be difficult to maintain the elevation of the Marine Sea. The analysis presented in Appendix H-4 does not specifically include a design for a seepage Barrier through the rockfill, but it does indicate that fine-grained material could be place on the upstream slope to control seepage. The Type 1 Barrier section would provide this seepage control. Seepage rates of about 20,000 acre-feet/year to 40,000 acre-feet/year could result in undesirable salt and water imbalances, unless the seepage was collected downstream of the Barrier and pumped back into the Marine Sea. The actual seepage blanket would be constructed of dredged clay materials between graded filter materials and stone slope protection.

Barrier and Perimeter Dike Design – Type 2

The Type 2 Barrier design has been developed by the Salton Sea Authority for Alternative 7, as described in Appendix I. This Barrier has not been evaluated to a comparable level as the Type 1 Barrier described in Appendix H-4. It is understood that the embankments would comply with all factors of safety. The slopes would be designed for a static factor of safety of at least 1.5 based on available information. Filter zones would be incorporated into the embankment design to prevent internal erosion of finer grained materials via seepage waters into the rockfill. The embankment would be constructed of nonliquefiable materials and the potentially liquefiable materials in the foundation would be removed. The design criteria for seismically induced deformations would be developed based on dynamic response analyses. It is anticipated that the lateral deformations would be limited to 3 to 5 feet. Seismically induced vertical deformations could be accommodated in a temporary loss of freeboard.

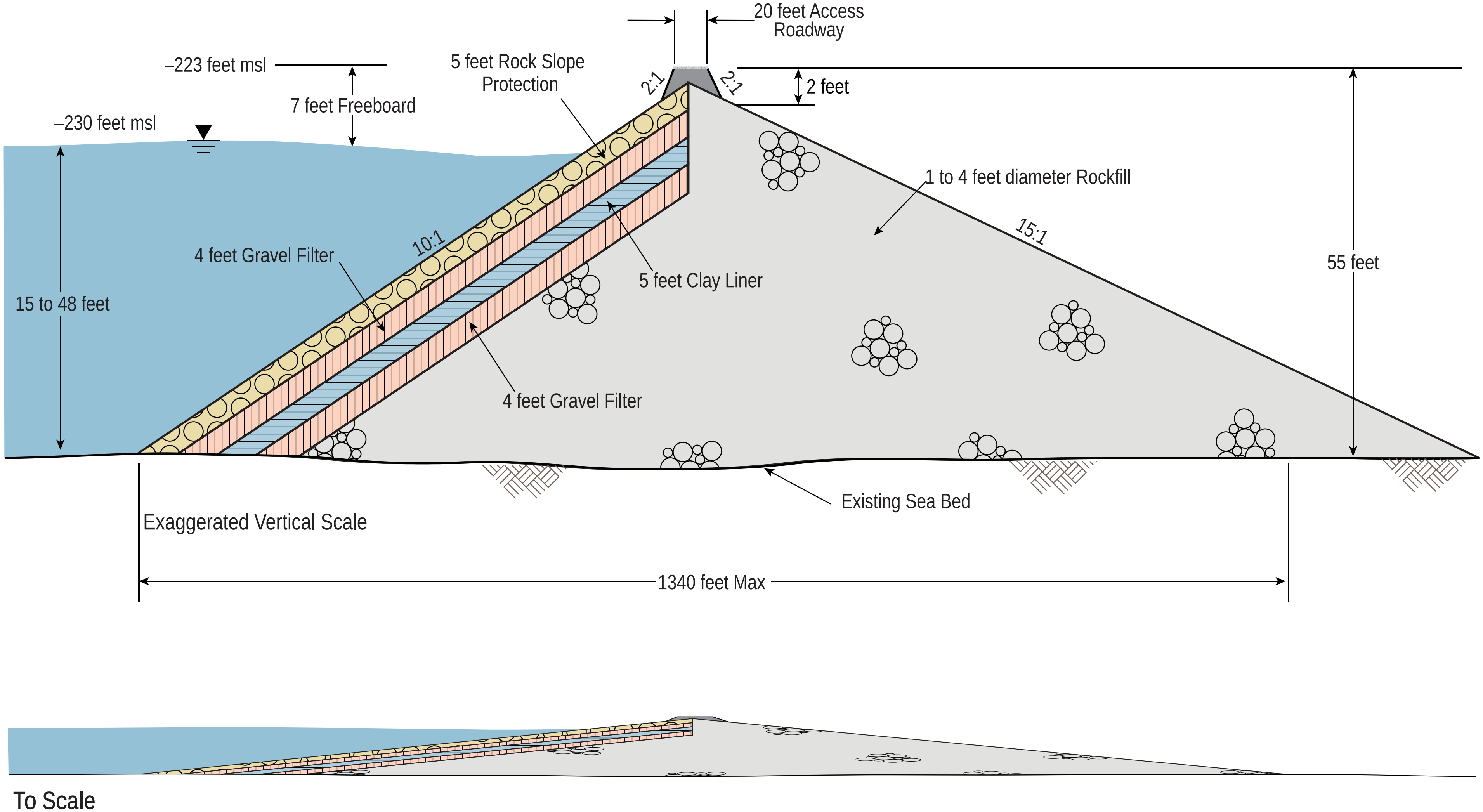

FIGURE H6-15
BARRIER SECTION
FOR ALTERNATIVES 5, 6, AND 8

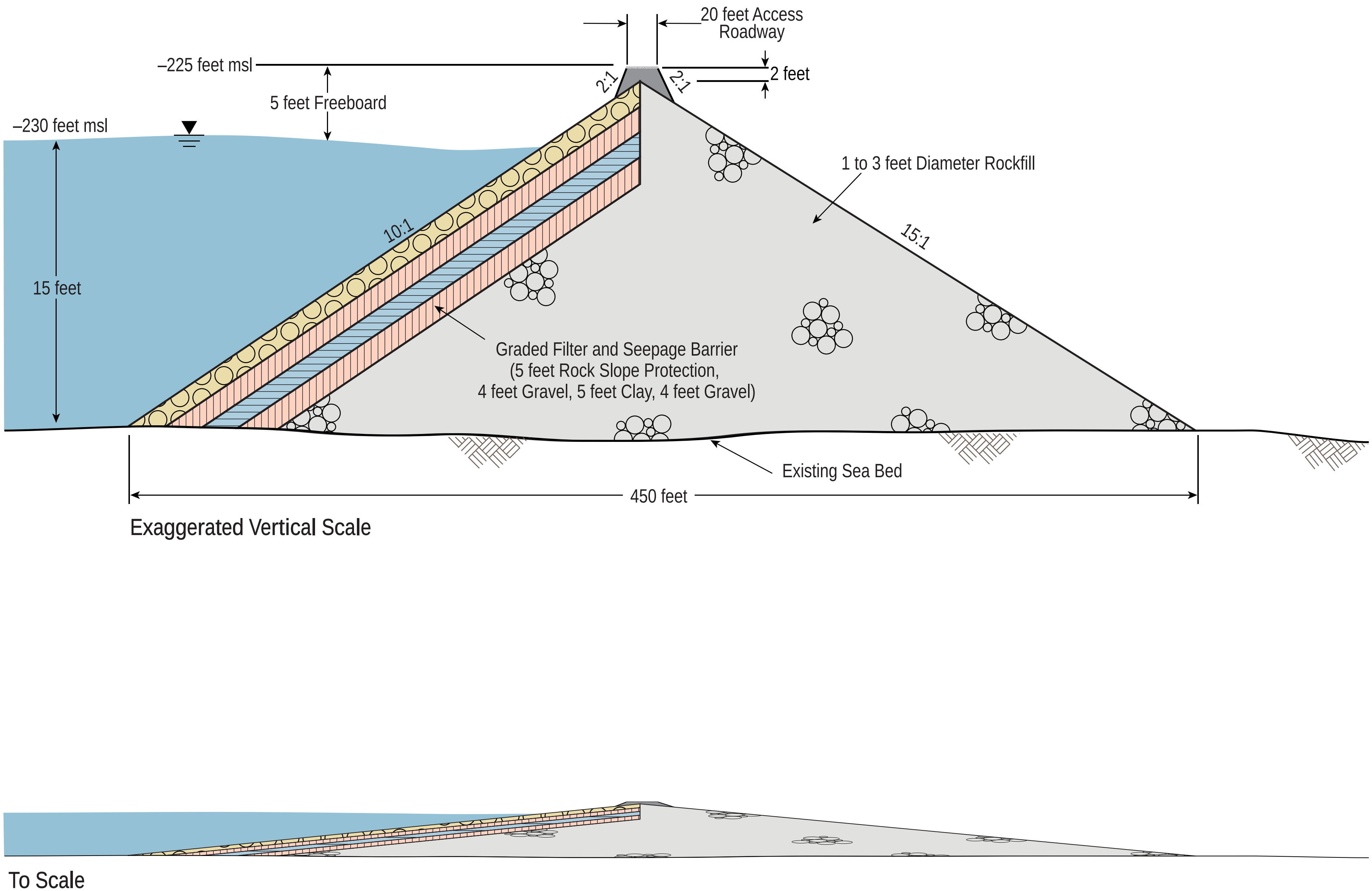

FIGURE H6-16
PERIMETER DIKE SECTION
FOR ALTERNATIVES 3, 6, AND 8

The removal of the soft sea floor and lacustrine deposits would mitigate settlement of the embankment, however, the estimated post-construction settlement would be accommodated with the embankment freeboard.

The proposed embankments would be built out of rockfill to significantly reduce the potential of seismically induced liquefaction of the embankment materials. The rockfill would be quarry run material with a maximum particle size of 1 to 3 feet. This material is similar to material used to retain shorelines of harbors in highly seismic areas, and in other rockfill dams. Larger rock, with maximum sizes of 4 to 5 feet diameter, would armor the slopes of the embankments exposed to wave action. Seepage would be controlled by constructing a bentonite slurry wall through the rockfill embankment, as shown in Figure H6-17.

The Type 2 Barrier/Dike stability would depend on the need for removal of the soft sea floor and lacustrine deposits and potentially liquefiable alluvial deposits. This material would be excavated from below the slopes of the embankment prior to Barrier placement to attain the required slope stability. In areas where potentially liquefiable soils do not exist, some soft lacustrine deposits could be left below the crest of the embankment. This design would not be expected to require long term maintenance.

Type 2 Perimeter Dikes would be of similar cross section as the Type 2 Barrier design, as shown in Figure H6-18. For Perimeter Dike sections constructed in shallower water of less than about 10 feet of water, the proposed seepage blanket could consist of corrosion resistant vinyl sheet pile rather than the bentonite slurry wall and filter.

Other Barrier Designs Considered

Results of foundation exploration could lead to foundation excavation and/or treatment. Foundation treatment could steepen side slopes, but any savings due to a reduced cross-section could be offset by additional foundation excavation and backfill costs. The impacts associated with dredging and relocating foundation materials could also be significant.

Other embankment designs are currently being considered by other entities and could be adopted in a project-level analysis. Reclamation, for example, is considering a Barrier with extensive foundation treatment to improve shear strength and allow for steeper side slopes. This involves a design that could require removing up to 20 feet of soil at the center of the Barrier, and then jet grouting the area below this to increase the overall foundation strength. The Barrier would have a low permeability core using a clay slurry wall to reduce seepage. The Barrier section would have an upstream slope of 5:1, a downstream slope of 7:1, and a top width of 20 feet.

Berms

Berms would be designed as low height, compacted embankments designed to retain water for various impoundments. Berms would be similar to levees and would be associated with the Saline Habitat Complex, the Shoreline Waterway, canal embankments above existing ground, and other compacted embankments retaining water six feet deep and less. Berms would be considered low risk facilities and would not fall under the jurisdiction of DSOD.

Berms would be constructed of suitable earthfill materials excavated from the Sea Bed and compacted in layers on the Sea Bed. The Berms would be constructed with 3:1 side slopes and have a crest width up to 20 feet wide for a gravel access road. Freeboard in protected areas, including Saline Habitat Complex areas, would be 3 feet above the maximum water surface. To improve foundation conditions, the top three feet of soil could be excavated prior to construction. The waterside slope of each Berm would be protected from wave erosion by placing rock slope protection on the side slope.

Because Berms would require compaction, these embankments would need to be constructed in the dry areas using conventional earthwork techniques. Their construction would occur when the water recedes. If Berms would be needed to be in place before the water recedes, alternative designs could be considered, such as Geotube® Berms or rockfill Perimeter Dikes.

Geotube® Berms

Alternative 4, as defined by the Imperial Group, includes the use of Geotube® Berms, as described in Appendix I. The Geotube® Berm would be a sediment filled, 60-foot circumference high strength geotextile fabric tube, placed on the Sea Bed to form a water retaining levee embankment. A geogrid material would be placed on the Sea Bed under the Geotube® Berm to provide adequate foundation for the Geotube®. The Geotube® would be filled with dredged sediments at the Barrier site in wet conditions. After filling, the entire Geotube® would be covered with an earthfill material from the Sea Bed and protected with rock slope protection.

A typical cross-section detailing Geotube® Berms is shown in Appendix I. Waterside slopes would be armored with rock slope protection within the zone of wave action. Landside slopes would be planted for slope protection. The Geotube® Berms would be similar to the Berms described above, in that they only retain a maximum water depth of 6 feet. Based upon the information presented by the Imperial Group (see Appendix I), the Berms are not anticipated to be under the jurisdiction of DSOD.

Foundation treatments would be designed once more geotechnical information is obtained. For purposes of the PEIR, it was assumed that the use of a high-strength geotextile would adequately minimize differential settlements along the Geotube® Berms. Additional freeboard would allow for up to 2-feet of total settlement before corrective measures or additional material would be used. To assist in foundation stability, about 20-feet of the soft lacustrine deposits would be stripped adjacent to the Geotube® Berms. The soft soils would be used for construction of habitat islands or non-engineered fill.

Geotube® Berms Construction Techniques

Construction of the Geotube® Berms would commence with placement of a high-strength geogrid for foundation stability. This geogrid would reduce possible differential settlement along the Geotube® Berms but would not prevent long term settlement issues. Immediately following that, a 60-foot circumference Geotube® would be placed over the foundation. The Geotube® would be filled either by sand or silt/clays, as either material could be used. The Geotube® would be filled by hydraulic dredge. Sand is preferred as the tubes would not be subject to much additional settlement after filling; however, sand is not essential. Once the Geotube® Berm is completed, then the area around the Geotube would be built up with placement of suitable silts/clay by mechanical means. Slopes of 5:1 over the Geotube® Berms would be anticipated. Once a Geotube® Berm would be completed and water levels recede, the dry slope would be graded to final grade. Rock slope protection would then be placed on the water side of the Geotube® Berm.

Sands, clays, and silts used in Geotube® Berms construction would be anticipated to be excavated from the Sea Bed. Soil investigations would identify the exact locations of these sources. Rock for the slope protection would be imported from upland sources.

Geotube® Berm production rates could ranges from 500 to 700 linear feet/day. This results in estimated production duration of about 1.75 to 2.5 years for the longer rings. To construct these Berms, up to five mechanical dredges, two small hydraulic dredges, and two medium hydraulic dredges could be required.

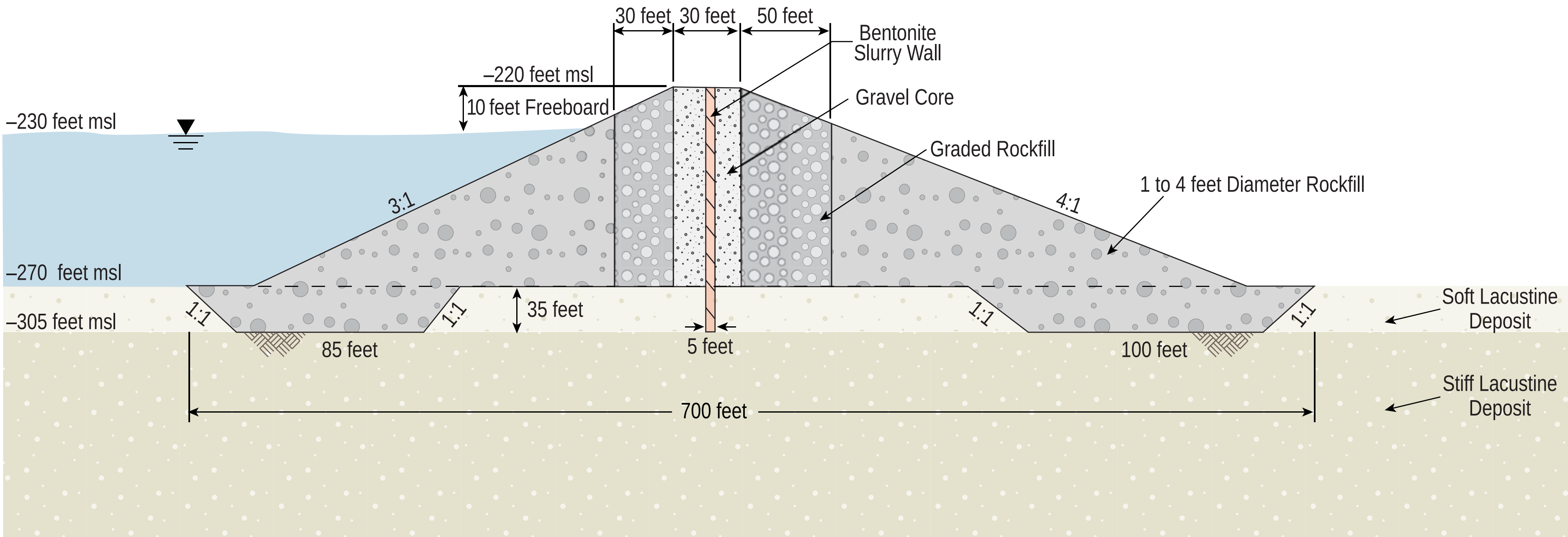

FIGURE H6-17
BARRIER SECTION
FOR ALTERNATIVE 7

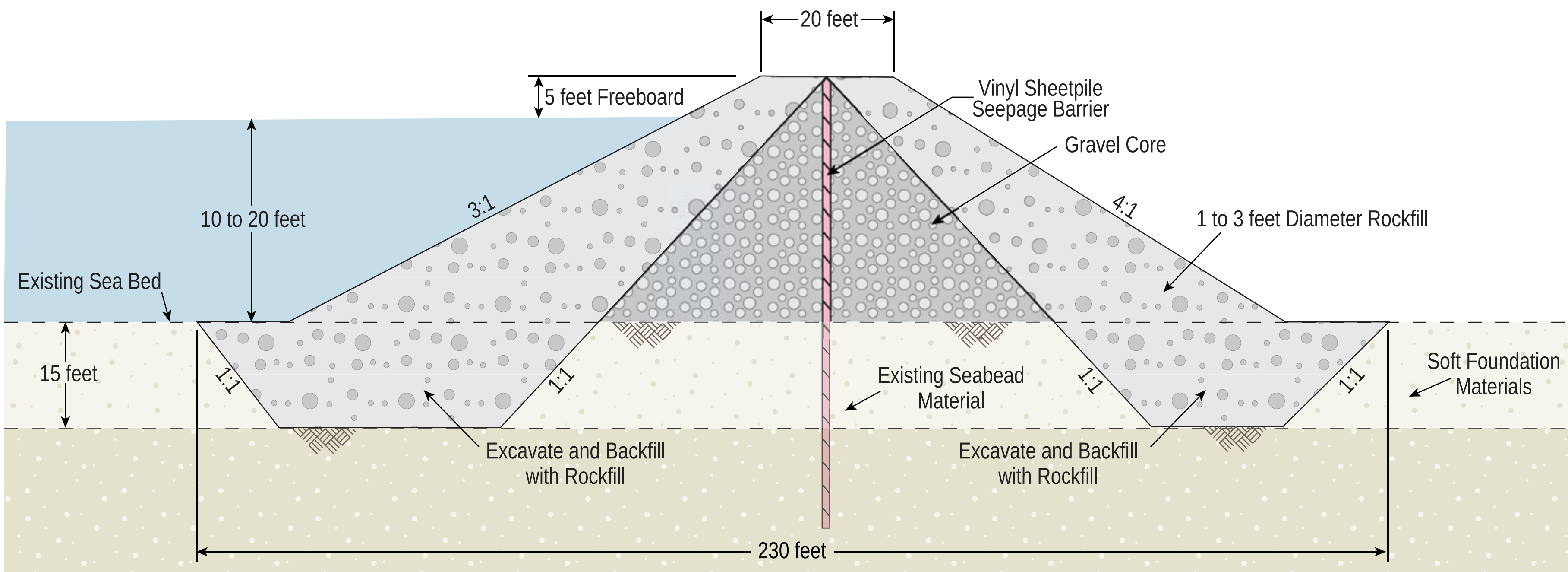

FIGURE H6-18
PERIMETER DIKE
FOR ALTERNATIVE 7

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Hydraulic and mechanical dredges would be utilized for all dredging. A lay barge would be employed for laying the Geotube® on the Sea Bed. Tugs and barges would be used to assist the dredging and laying operations. Rock would be transported on barges and placed by mechanical means from a barge. Minimal shoreside support facilities would be required for this operation. The primary shoreline facility would be the rock transfer facility. This would require a pile-supported trestle and appropriate mooring facilities to support the rock loading operation.

IID Reservoir Barriers

The 255,000 acre-foot IID Reservoir is considered in Alternative 7 as proposed by the Salton Sea Authority. However, during project-level analysis, the reservoir could be added to any of the alternatives. The reservoir could be located in a manner to reduce Air Quality Management of Exposed Playa.

Management of the reservoir has not been defined. The alternative assumes that the reservoir would store Colorado River water in the same manner that IID uses other reservoirs. Therefore, annual drawdown and fluctuations, between empty and full conditions, would be anticipated. For the purposes of the PEIR analysis, it was assumed that the reservoir would be formed using a Type 2 Barrier, as described above.

Water intake and outlet facilities would be necessary. For estimating purposes, a separate intake structure, isolated from all other features, was assumed. Water supply canals and related conveyance facilities directly related to the reservoir were not included or described in the alternative. Similarly, a pumped outlet would be required to remove water from the reservoir to IID system.

The reservoir Barrier, intake structure, and pumped outlet are included in the cost estimate in Appendix H-7. However, all related water conveyance infrastructure, access roads, and maintenance facilities are not included in the estimate or described in the alternative.

The footprint of the proposed reservoir would reduce the Exposed Playa by 11,000 acres.

The construction of this reservoir would begin following completion of the Barrier and Perimeter Dike for the Recreational Saltwater and Estuary lakes. Methods of constructing the reservoir Barrier would be similar to those used for the Barrier and Perimeter Dikes, with construction primarily in inundated areas using barges for placing the majority of rock. However, because this reservoir would be constructed after the Barrier would be completed, additional barge staging areas for rock transport could be needed. The construction and operations and maintenance of this reservoir would be considered to be independent of other construction activities. It is not expected to influence the construction or operations and maintenance activities of the other components.

AIR QUALITY MANAGEMENT FACILITIES

The alternatives have been developed in the PEIR with conservative assumptions for Air Quality Management water demands. As the playa becomes exposed and monitored to determine emissivity, the amount of water needed for Air Quality Management facilities could become less than projected in the PEIR. However, the re-allocation of this water would only be considered after a long term monitoring period to determine that the soils do not become emissive. After the monitoring period, water not required for the Air Quality Management could be used by other components.

Potential Air Quality Management concepts are described in Appendix H-3 and Attachment H6-1. Application of the Air Quality Management is described for each alternative in Appendix H-7.

Air Quality Management that would require water-based infrastructure would include water efficient vegetation with subsurface drip irrigation and stabilization with brine for areas near the Brine Sink where sustaining vegetation may not be possible. The latter method would keep areas damp or be used to create a non-emissive salt crust. Because each of these methods use water, substantial infrastructure including filters, pumps, piping, control gates/valves, low height levees, and drainage systems would be required.

Design Considerations for Water Efficient Vegetation

The water efficient vegetation areas could be located anywhere on the Exposed Playa. Water would be diverted from the Air Quality Management Canals and conveyed to the filter units or to saltwater blending facilities as required for the water efficient vegetation system to function. The canal turnout facilities would either be gravity diversions or include pumping plants, as necessary. Water blending facilities would be used to provide water of the appropriate salinity for the irrigated plants, about 10,000 mg/L. Saline water for this system would be from a saltwater conveyance system, as described earlier. For purposes of the cost estimates presented in Appendix H-7, saltwater would be pumped from the Brine Sink, Marine Sea Mixing Zone, and/or Marine Sea Recirculation Canal.

Air Quality Management could be implemented as the Sea Bed is exposed. For the purposes of the PEIR, a 2-square mile “buildable unit” was assumed for Air Quality Management. Within each unit, all the necessary water treatment and delivery systems would be included. Filter units and primary irrigation distribution controls would be located along the upper contours near the Air Quality Management Canals to facilitate access. Supply pipelines for the subsurface irrigation lines, as well as drain systems, would be extended as the water recedes. A list of major materials for each 2 square-mile area is included in Attachment H6-1.

Each buildable unit would be constructed on dry exposed Sea Bed. As described in Appendix H-3, it is assumed in the PEIR that buried drip irrigation and subsurface drainage would be necessary to represent the most conservative approach related to water and costs. The buried irrigation systems would reduce potential for selenium toxicity to wildlife from ponded water. The drainage systems would initially reduce soil salt content, and then would be used to maintain conditions favorable to plant growth.

Establishing drainage to leach salts from the soils would be developed prior to construction of the irrigation system. This would require excavating trenches throughout the area to facilitate drainage to support plant growth. Trenches may be up to 8 feet deep and spaced to allow drainage of the soils. Slotted pipelines, similar to those used for tile drains in agricultural areas would be permanently laid in these trenches. The buried drip irrigation pipelines would be installed within 1 foot below the ground surface on 5 to 10-foot centers. These irrigation lines would minimize water use to grow the vegetation and prevent unintentional ponding of water on the ground surface.

In general, facilities would be constructed in such a way that flood runoff could flow to the Brine Sink with a minimum of dedicated flood control facilities and without significant damage to other facilities.

Drainage flows would be conveyed to the Brine Sink or recycled to the filter units. Although some constituents would become concentrated in the Brine Sink. This is not anticipated to become an ecorisk issue because, except under the No Action Alternative, the irrigated areas would not be constructed until Phases II or III. By that time, the Brine Sink salinity would have been greater than 350,000 mg/L for more than 5 or 10 years.

Design Considerations for Stabilized Brine

As described in Appendix H-3, the area near the Brine Sink may have a high saline groundwater level that could not be drained to support plant growth. Saltwater from the Brine Sink or other saltwater source could be used to create a salt crust or to dampen these areas periodically. Infrastructure necessary for this system would include saltwater pumps, surface pipelines, and/or portable hoses.

Supplying and distributing saltwater to these systems would be difficult due to the fluctuating Brine Sink water elevation. For the PEIR, it was assumed that a number of deep trenches would be excavated from the Brine Sink to upgradient areas that would be accessible by a maintenance vehicle. At the end of this deep saltwater canal/trench, a saltwater pumping plant, installed on a platform, would draw water into a pipeline distribution system. Water would then be distributed through above ground pipes to a portable hose or irrigation pipe system for periodic delivery of saltwater to the emissive areas. Like the water efficient vegetation areas, 2-square mile “buildable units” were estimated for the PEIR analysis.

Design Considerations for Salt Crystallizer Ponds

Under Alternative 7, Air Quality Management at elevations below -255 feet msl would use a stable salt deposit on Exposed Playa rather than water efficient vegetation. The salt deposit criteria would be based upon information developed in recent salt pond projects along the Salton Sea shoreline (Agrarian Research, 2003; Reclamation, 2004). The studies suggested that a 1.6 foot thick salt deposit could occur in one year in salt crystallizer ponds. Additional information provided by the Salton Sea Authority (Pyles, 2006), included in Appendix I, indicate that using methods from commercial solar salt industry could increase the efficiency of this process. The information suggests that once the salinity in the salt crystallizer ponds exceeds a target value, the remaining supernatant, or brine, would be decanted and channeled to the Brine Sink. For the PEIR, it was assumed that the salt crystallizer ponds would be constructed with Berms on 3 to 5-foot contours on the Exposed Playa. The flows would be diverted from the last cells in the Saline Habitat Complex. Because of upwelling, seepage, and rainfall, the information provided indicate that the protective salt crust could need to be rebuilt on a 10-year cycle. Once a salt deposit was formed in one salt crystallizer pond, the brine water from the Saline Habitat Complex would be routed to other salt crystallizer ponds on a rotating basis.

Brine demand would vary with brine concentration. In general, as brine salinity increases, the least soluble salts precipitate, increasing the proportion of chloride in the brine. Data from the Solar Pond Pilot Study (Agrarian Research, 2003) was used to develop this relationship. Brine demand for a range of brine salt concentrations was calculated based on these assumptions, as presented in Appendix I. The range of brine demand flows were calculated, as summarized in Table H6-4.

Table H6-4
Basis of Annual Brine Demand Estimates

Brine Salinity (mg/L)	Brine Application Rate (acre-feet/acre/year)	Brine Demand if Area is 63,000 Acres (acre-feet/year)
42,817	7.3	458,895
50,000	4.5	286,524
75,000	2.9	181,262
100,000	2.1	132,878
150,000	1.4	88,716
200,000	1.1	66,842
250,000	0.8	50,275
300,000	0.6	35,178

WATER QUALITY MANAGEMENT FACILITIES

Water quality management features in the alternatives would be primarily limited to salinity management facilities, water circulation to maintain salinity, and sediment control. Salinity control would occur through blending, managing inflow and outflow rates, and circulation, as discussed above as part of the description of conveyance facilities. Use of Sedimentation/Distribution Basins to remove sediments also was discussed above. It should be noted that a portion of other constituents, such as nutrients, would be removed with the sediment.

Alternative 7 would include two additional treatment plants, as described in the correspondence found in Appendix I. These facilities were included in the development of Alternative 7, including the water balance and cost estimates. One of the treatment plants would be constructed at the confluence of the Alamo River and would remove phosphorus. All of the alternatives include a reduction of phosphorus (potentially up to 50 percent) in the inflows due to reduction of phosphorus in the inflows from Mexico and implementation of the TMDLs in the watershed. Alternative 7 provides further reductions in inflow phosphorus loads through this water treatment plant. It is assumed that the combined reduction in phosphorus loads in the inflows could be up to 90 percent. The impact on water quality of the 50 and 90 percent reductions are described in Appendix D. However, as described in Appendix D, the reduction in phosphorus in the inflows would not cause reductions in phosphorus in the Marine Sea or Recreational Saltwater Lake unless phosphorus concentrations in the sediments also were reduced by at least 50 percent. This would occur over several decades after inflow phosphorus loads were reduced.

Alternative 7 also would include an intake in the deepest portion of the northern subbasin in the Recreational Saltwater Lake to withdraw water for treatment by sand filtration and ozonation. These processes would oxidize soluble constituents and constituents associated with suspended solids that would occur near the bottom of the water column. However, it is not known, if an adequate amount of materials would be removed through withdrawals from the water column to reduce the internal loadings of nutrients in the Recreational Saltwater Lake in a noticeably shorter period of time than would occur without the water treatment plant.

For the purposes of Alternative 7 in the PEIR, the treatment plants were included in the water balance and cost estimates. It was assumed that the sludge from both water treatment plants would be placed in the Brine Sink, however, the Brine Sink is extremely small in this alternative. Therefore, the sludge could become a large portion of the Brine Sink.

It is not known if the treatment plants would be able to reduce internal and external nutrient loads to a level that would improve water quality noticeably as compared to the assumed 50 percent reductions in both loads in all of the alternatives, including the No Action Alternative. The analysis presented in Chapter 6 includes the 50 percent reduction in inflow and internal loads for all alternatives. The potential for 90 percent reduction in inflow and internal loads was analyzed for Alternative 7 in Appendix D.

OTHER INFRASTRUCTURE FEATURES

Infrastructure not described as part of the features above are described in this section, including Marine Sea outlets and siphons, spillways, control structures, access roads, fencing, and infrastructure for non-habitat features.

Marine Sea Outlets

To maintain stable salinity in the Marine Sea, salt must be exported from the Marine Sea equal to the net salt entering the Marine Sea. At a salinity of 35,000 mg/L, a volume of 70,000 acre-feet would contain about 3,000,000 metric tons of salt. By conveying 70,000 acre-feet/year, or about 100 cubic feet/second of constant flow for 24 hours/day, from the Marine Sea to the Brine Sink, the salt outflow would about equal the salt inflow. To convey at least 100 cubic feet/second, an outlet would be constructed near the shoreline of the Marine Sea near the intersection with the Barrier with an excavated channel in the Marine Sea to deliver marine water to the outlet. The excavated channel would be relatively deep to withdraw water from the deepest portion of the Marine Sea to promote circulation in the water body. A 3-foot square gate would convey about 100 cubic feet/second with about 5 feet of hydraulic head above the centerline of the gate. A second gate would allow operational flexibility to discharge additional water if needed. The outlet would not be constructed through the rock Barrier to avoid settlement. Instead, the outlet would be incorporated into the side of the spillway structure that would be constructed on cellular cofferdams or excavated into a channel at the end of the Barrier.

In some cases, a siphon over the top of the rock Barrier would be preferable to the traditional outlet facility described above. Two 4-foot diameter pipes could serve the same function as a gated outlet structure. A small pump would be used to fill the pipes and the outflow would be regulated by a valve. Due to potential gypsum and biological fouling of the pipelines, as described by Reclamation (2004), the open channel outlet was assumed in the PEIR. Siphons could be considered in special areas during project-level analysis.

Spillway

The spillway to protect a Barrier would need to be substantially larger than the spillways at the Sedimentation/Distribution Basins to convey the probable maximum flood (PMF) or some fraction of the PMF. The probable maximum precipitation was estimated based on the Hydrometeorological Report No. 58, Probable Maximum Precipitation for California – Calculation Procedures (NOAA, 1998) and Hydrometeorological Report No. 59, Probable Maximum Precipitation for California (NOAA, 1999). Due to the large drainage area of more than 8,000 square miles, and the relatively large size of the Marine Sea and Recreational Saltwater Lake, it is likely that the PMF would result from the general storm probable maximum precipitation (such as the 1976 hurricane) rather than from the local storm probable maximum precipitation.

For the PEIR, a detailed PMF was not computed for the Salton Sea, but the volume of the flood was estimated. The design of the spillway would likely be more sensitive to flood volume than peak flow. Based on preliminary estimates of precipitation, and assuming a minimum infiltration rate of 0.2 inch/hour, the volume of inflow to the Marine Sea or Recreational Saltwater Lake could be 750,000 to 1,000,000 acre-feet per storm. Depending on the configuration of the Barriers, all or a portion of the peak volume would enter the Marine Sea or Recreational Saltwater Lake. A labyrinth spillway similar to those described above for the Sedimentation/Distribution Basins was assumed for the PEIR; however, other configurations for the spillways are possible. The spillway for a full PMF would require a structure about 1,100 feet wide.

Other Water Management Control Structures

There are many other minor water control structures necessary to manage the distribution of water in each alternative. These facilities would include flashboard weirs, slide gates, and radial gate structures. Many of these facilities could be remotely operated. For purposes of the PEIR analysis, manually controlled water control facilities that could meet the intended water control functions were assumed.

Access Roads

Access roads would be provided along major canals, Berms, Perimeter Dikes, and Barriers. These access roads would be necessary for construction and operations and maintenance as well as monitoring activities. Additional roads would be necessary to access remote facilities and monitor specific areas. Providing access roads to these areas would keep vehicles and personnel on dedicated roads and reduce disturbance of Exposed Playa. For the purposes of the PEIR analysis, 100 miles of additional access roads would be constructed within the Sea Bed in addition to the access roads included as part of the canal and Barrier features. These roads would be raised slightly above the Exposed Playa surface and covered with a gravel base to reduce dust emissions.

Fencing

Fencing would be provided for both security and safety purposes as necessary. Open canals could be fenced with 3-wire fencing to limit access and provide safety along the larger canals. Fences could be provided to limit vehicle access to habitat areas or Exposed Playa.

For purposes of the PEIR, it was assumed that chain link security fencing would be provided around large facilities including pumping plants, filter units, major control structures, outlet/spillways, water treatment facilities, and other security features.

Electrical Systems

The alternatives include a wide variety of potential pumping plants and water control facilities that would require power. Table H6-5 summarizes the electrical loads for typical installations.

These loads would be investigated further in a project-level analysis. A more detailed analysis of electrical loads in each alternative is presented in Appendix H-7.

Distribution or transmission lines would need to be provided to the various areas around the Sea Bed to extend electric service for the various infrastructures. For the PEIR analyses, it was assumed that power would be provided by an outside utility to the point of use. Distribution and/or transmission line routes would be evaluated in the project-level analyses.

CONSTRUCTABILITY

Constructability describes the contractor’s ability to complete the work as specified and within the timeframe anticipated for construction. Major constructability issues for the alternatives would be related to transport of large quantities of construction material to the Salton Sea, the need to wait for the water elevation to recede before constructing some portions of the infrastructure, and the need to construct portions of the infrastructure under water or in saturated soil conditions. It appears that over several decades, the infrastructure associated with the alternatives would be constructible. The following discussion related to constructability includes assumptions related to construction staging, material sources, special construction methods, and contractor staging areas.

Construction Staging

Consideration of how the infrastructure can be constructed over time is critical to understanding of the construction schedule. Some facilities require the water to recede before facilities could be constructed. Therefore, construction would be scheduled as the inflows decline. If inflows remain at higher levels for longer periods of time, some facilities would not be constructed for many years after the scheduled time period. Maintenance of high inflows also could impact the ability of a Marine Sea to discharge salts to reduce salinity to 30,000 to 40,000 mg/L if the water in the vicinity of the Brine Sink did not decline as projected. If inflows decline more rapidly than projected in the PEIR, the Exposed Playa could be exposed prior to construction of Air Quality Management facilities and another type of dust control may need to be implemented on a temporary basis. The stochastic analysis conducted for each alternative shows the possible range of inflows that could occur and the corresponding range of water levels that could occur under the range of inflows, as described in Appendix H-2.

Table H6-5
Estimated Energy Requirements for Alternatives

	Alternatives									
	No Action Alternative - CEQA Conditions	**No Action Alternative - Variability Conditions**	**(1) Saline Habitat I Alternative**	**(2) Saline Habitat Complex II Alternative**	**(3) Concentric Rings Alternative**	**(4) Concentric Lakes Alternative**	**(5) North Sea Alternative**	**(6) North Sea Combined Alternative**	**(7) Combined North and South Lakes**	**(8) South Sea Combined Alternative**
Installed Megawatts	5.2	5.2	8.5	10.2	13.0	0.2	13.5	14.0	8.8	13.7
Maximum transmission line capacity needs (Megawatts)	3.5	3.5	5.7	6.7	9.1	0.2	9.4	9.6	7.2	9.5
Average transmission line capacity needs (Megawatts)	1.1	1.1	1.8	2.1	3.1	0.9	2.9	3.4	5.0	3.4
Estimated annual demand (Gigawatt-hours)	9.98	9.98	16.07	18.71	27.17	7.85	25.63	29.78	43.70	29.44

Many facilities would be constructed in inundated and dry areas. Facilities that must be constructed in the dry areas include Sedimentation/Distribution Basins, canals, Air Quality Management facilities, Saline Habitat Complex, and Berms. Since many of the canals are located along the shoreline, these areas are likely to be exposed in Phase I. Barrier facilities would be constructed in inundated conditions and could be initiated as soon as possible before the water recedes and precludes use of barges. Construction of Barriers and Perimeter Dikes would require construction of harbors to load rock onto the barges. Barrier construction also would require dry area construction methods once the Barrier height is too high to allow further construction from barges.

Staging of construction could be required to limit air quality emissions during construction. For purposes of the PEIR, peak construction emissions were calculated during each phase, as described in Appendix E, and were based on a Barrier construction over 7 years with other major construction activities occurring during the same period. If Air Quality Management permits do not allow high levels of construction activities, construction may need to be staged over longer periods of time. If this occurs, there would be delays in reducing salinity in water bodies and providing habitat.

Material Sources

The materials considered in the PEIR analysis include rock for Barriers and Perimeter Dikes and Sea Bed materials for Berms, habitat islands, and peninsulas.

The Barriers and Perimeter Dikes would be the main facilities that would require construction material from outside the Sea Bed. As described above, the specific location of the rock sources was not defined in the PEIR. Gravel also would be imported for use on top of roads and Berms.

Most of the materials for Berms would be excavated directly from the Sea Bed adjacent to where the material would be needed. Canal embankments would similarly be constructed from material excavated for each canal. The larger canals would produce significant quantities of excavated material that could be disposed within the Sea Bed or used to construct habitat features such as islands or peninsulas.

Special Construction Methods

The methods and equipment used to construct the various facilities would need to be developed through project-level analyses. For example, conveyors could be used to transport rock that is 20-inches or less in diameter. Rock in the 3 to 4-foot diameter range would likely require transport by large trucks or railroad cars.

Many facilities would be constructed by using traditional construction methods and equipment. Most of the canals, pumping plants, pipelines, concrete structures, Air Quality Management facilities and habitat areas would not require special construction methods or equipment. However, construction of the Barriers and the larger canals would likely benefit from use of special construction methods and equipment. Production estimates used in developing construction schedules in the PEIR were based on 30,000,000 tons of embankment material in a Barrier with the unit weight about 1.68 tons/cubic yard (e.g., typical for Eagle Mountain Mine waste rock). To complete the Barriers as soon as possible, it was assumed that Barrier construction would occur 24 hours/day for 7 days/week for 4 years. However, final permit conditions may not allow this level of construction activity due to community disruption, Air Quality Management permitting, or high winds that would significantly limit the ability of barges to conduct operations. For purposes of this analysis, an aggressive schedule was assumed to estimate worst case impacts to air quality and equipment needs.

Specific issues related to obtaining, transporting, and placement of rock for Barriers and Perimeter Dikes are discussed in the following subsections.

Quarry Loading and Hauling

Blasting of the rock is assumed to be performed at the discretion of the supplier and would be conducted to meet construction needs. Once the rock is broken, it would be excavated and loaded into large-capacity mine hauler trucks for a short haul to a handling area. This would require a large excavator loader such as a Terex RH-120E, which could load at about 2,100 tons/hour. Terex TR-70 mine haul trucks of 72-ton capacity would need to make some 294 round trips/day to a segregation facility. For a three-mile haul at 30 minutes/round trip (including loading) in two shifts, ten trucks would be required. If larger hauling equipment was available, the number of round trips would be reduced.

Transporting Rock from the Quarry

A combination of transportation methods could be used to move rock from the quarry. The most viable options for the quarry sites near the Salton Sea probably would be to use mine hauler trucks, side dump rail cars, or conveyor systems. If rock was transported from sites over 10 miles away, multi-car railroad trains could be used. If the Eagle Mountain Mine was used, the existing railroad would need to be repaired and an additional track or siding could be constructed to meet production rates.

Transport methods for gravel from the aggregate quarries would depend on the haul distance, quantity of rock delivered, and the size of rock. For purposes of the PEIR, the following methods were assumed for movement of large rock:

- **Mine hauler trucks –** These large dump trucks have an effective range over a 5-mile haul and most effective for hauling larger rocks. Terex TR-70 mine haul trucks of 72-ton capacity would need to make some 294 round trips/day. For a 5-mile haul at one hour/ round trip (including loading) in two shifts, twenty such trucks would be required. Larger hauling equipment is available, which could reduce the number of round trips. This truck could take rock directly from the excavation or loading site to the barge, avoiding a transfer of the material at the shoreline;
- **Side dump railroad cars –** This method would be most effective for large rock hauls longer than 5 miles. This method would require the rock to be hauled by mine hauler to the railhead, and transferred by crane for the larger rock or conveyor for the smaller rock into the railroad cars. Off loading into a dry land stockpile at the shoreline would be feasible, but direct offloading onto barges may only be feasible for the smaller sized rock. Use of side-dump cars with standard 70-ton capacity would require 295 car deliveries/day. Ten 30-car trains/day could accomplish this with single engines because most of the loaded haul route is downhill.
- **Conveyor –** This may be the most efficient system for medium hauls and is electrically powered. The required tonnage could be easily delivered by conveyor, for smaller rock sizes. One example is a 4-year old 48-inch stacker system that moves 1,050 tons/hour, and builds twin stacks, (one 26,000 ton and one 33,000 ton), that could fill two barges. With a 0.25 mile conveyor and a 700-foot wide stacker, this system would use a single 100 horsepower drive motor (convey) plus a 20 horsepower (traverse). Conveyors would be built in modular sections as are common in the mining industry for hauls up to about 25 miles. Grade separations and wildlife crossings could be created under the conveyor between support bents. Conveyor systems are commercially available and can be mobilized quickly. Loading of barges and other means of final placement would be direct and efficient. During the project-level analysis, details could be developed for placement of a conveyor constructed along the top of the Barrier to allow direct placement of rock on top of previous layers when the height becomes too high for placement from the barges. If the conveyor is not constructed, a trestle would need to be constructed parallel to the Barrier or Perimeter Dike to deliver the rock to the high positions on the Barrier or Perimeter Dike.

Rock would need to be sorted by size at some point in the delivery chain. This could occur at the quarry or at the shoreline facilities.

Foundation Dredging

Dredges could be used to excavate the Barrier and Perimeter Dike foundations and to place fine material on the upstream face of the Barriers or Perimeter Dikes to control seepage. One mid-sized and one small-sized dredge could be used to excavate prior to the rock fill placement. The small dredge could be sized to also work in canals. The combined capacity of the dredges would be adequate to meet the production of Barrier or Perimeter Dike formation and allow completion of canal dredging at the same time as the Barrier or Perimeter Dike. This capacity would depend on the depth and width to be excavated. For the purposes of the PEIR, it was assumed that the capacity would be 50,000 cubic yards/month.

Rock Placement in Barrier

Barges would most likely transport the majority of the large sized rock from the shoreline facilities for placement of the Barrier or Perimeter Dikes. Barges are assumed to be capable of conveying 800 tons of rock in each load. To complete the Barrier and/or Perimeter Dikes within four years, there would need to be 24 round trips/day, 7 days/week. Flat-top barges could be used to supplement the delivery capacity. The Barrier would be constructed from one shoreline to the other shoreline. As construction of the Barrier progresses, unless rock is delivered from both the western and eastern shorelines, the length of the round trips would increase because the haul length would increase.

Rock would be dropped from the barge onto the Sea Bed. Some segregation of the rock would be expected as the rock drops through the water. The required depth of water from the barge deck to the bottom of the barge (also referred to as the “draft”) would be about 20 feet. Flat-bottom barges require about a 10-foot draft but have a smaller capacity than bottom-dump barges. It would be more difficult to remove rock from the flat-bottom barges than bottom-dump barges. To remove rock from the flat-bottom barges, the operator would need to push the rock with a small bulldozer; cant with a trippler-type rig (a large tilting table); or cant the craft itself by compartmental flooding to tip the platform.

The top layer of the Barrier or Perimeter Dike would need to be placed by pushing material out from the abutments with bulldozers, conveyors, or by a trestle bridge parallel to the Barrier or Perimeter Dike. This method would extend the top portions of the Barrier or Perimeter Dike by pushing material onto the Barrier with bulldozers. Material would be delivered to the end of the Barrier or Perimeter Dike by truck or conveyor. The pushed slopes could be unstable or segregation of the rock as the material rolls down the face of the submerged sloped. These conditions could lead to sudden localized failures that could endanger construction equipment and personnel. Methods would need to be developed to flatten the slope of the advancing fill to prevent these failures. In addition, methods would need to be developed to side-cast the material beyond the advancing centerline of the Barrier or Perimeter Dike to achieve the flatter slopes. The flatter slopes could be achieved by a conveyor system on pontoons or other supports that could deposit material on the sides and front of the advancing fill. It may be more effective to install a trestle on piles along the axis of the Barrier for rock placement.

Excavation of Large Canals

Excavation of canals around the shoreline could occur in areas with high groundwater levels and soft soil conditions. The following four methods could be used to excavate under these conditions:

- **Dry Excavation –** As the water recedes, canal excavation in dry conditions would be possible using a combination of excavators, scrapers and bulldozers. A well point system, or other dewatering system, could sufficiently remove groundwater prior to excavation. Since most large canals would not be needed until Phase II when the Barrier and Perimeter Dike construction would be complete, a dewatering system could operate for several years, if necessary, before excavating the canals along the shoreline;

- **Wheel Conveyor Excavation –** This method would use a broad wheel cutter that feeds a conveyor system to remove the soil from the excavation. The wheel would be at the end of a radial arm that sweeps the excavation face. The equipment could include a low-pressure ground tracks to allow operation in the soft soil conditions;
- **Placer Excavation –** This method would use water jet to loosen and move the soil away from the excavation. This excavation method could be combined with a slurry pipeline to transport the excavated material long distances over several miles to build habitat islands or peninsulas; and
- **Dredging –** Shallow draft, medium-sized dredges could be used to excavate the larger canals. Temporary levees could be constructed to allow adequate water depth for the dredges. Spoils could be conveyed in a slurry pipeline to the deeper parts of the Brine Sink or to habitat islands or peninsulas locations.

Construction Staging Areas

Most of the laydown and staging areas would be within the Sea Bed, as summarized in Table H6-6.

Large equipment, such as barges and dredges, would need to be delivered in sections, unloaded by crane, and assembled on-site. Transport of this equipment to the site would most likely be by railroad. A staging area to assemble equipment could be provided along the eastern shoreline. A new dredged harbor for docking the barges would be excavated in the Sea Bed adjacent to the eastern and possibly western shorelines to provide circulation and turning of the watercraft. After construction, the harbor could be retained for maintenance craft, converted for public use, or restored to pre-construction conditions.

Table H6-6
Estimated of Construction Staging Areas

Facility with Construction Staging Area	Estimated Surface area (acres)
Dredged harbor	40-50
Barge and tugboat assembly and maintenance	18-24
Barge ways	14-20
Conveyor stockpile	14-18
Barge loading for large rock	10-14
Storage and fueling	14-18
Equipment maintenance, shops and storage	10-14
Offices	5-8
Total	**125-166**

The eastern and southwestern shoreline areas could accommodate rock receiving, handling, segregation, and stockpiling facilities, and areas for loading of rock delivered from the quarries. Shoreline facilities could include temporary piers, docks, loading equipment, conveyors, crushers, screens, cranes, storage for material other than rock, offices, shops and laydown areas for equipment. The harbors would be designed to accommodate barges and dredges and service water craft.

MATERIALS SELECTION AND OPERATIONS CONSIDERATIONS

The saline environment would require special material selection considerations. Based on experience in operating facilities in similar conditions, corrosion and fouling issues are probably some of the more critical considerations in selecting the appropriate materials and designing infrastructure to minimize operations and maintenance costs.

Corrosion of Materials

Most of the water bodies would have moderate to extremely high salinity that would create high potential for corrosion. Based on available information, it is anticipated that the materials used in the alternatives would be selected based upon the following criteria.

- Avoid aluminum, galvanized (zinc-coated) steel, yellow brass, iron and steel without specified coatings;
- Use Type 316 stainless steel and avoid types 303, 304 and any alloy in the 400 series;
- Do not use submerged or buried stainless steel unless it is connected to a larger mass of iron or steel;
- Use "dezincification-resistant" bronzes which limit the zinc and certain other alloying elements because many high-copper alloys (bronzes and red brass) are compatible with seawater;
- Do not use copper that would destruct with ammonia and acids, including waters containing fertilizers;
- Use iron and steel only with fusion-bonded epoxy coatings and only if other materials are impractical;
- Use cathodic protection for most facilities. An impressed current type of cathodic protection system, which uses rectifier power sources, would be required. Careful monitoring and periodic replacement of the cathodic protection would be required;
- Specify concrete in accordance with ACI 318 (type V cement with pozzolan, rich mix, low water-cement ratio, and minimum of 2 inches cover over embedded steel reinforcement), and possibly include a coating of epoxy or waterproofing membrane;
- Use only wood that is marine-grade or protected with preservative on painted surfaces;
- Use fiberglass only with ultra-violet inhibitors in the resin and possibly with painted coatings for extra protection; and
- Do not use polyvinylchloride and similar plastics that would probably embrittle over time with sunlight exposure.

Fouling of Materials

The Salton Sea Salinity Control Research Project (Reclamation, 2004) results describe a range of issues associated with operation of solar ponds, pumps, pipes and intake structures at the Salton Sea. For example, the study found gypsum fouling in all closed conduits that conveyed brine. Barnacle fouling of the intake pipeline and fish screen at the Salton Sea was a major problem until the system was fitted with a Radiant Energy Forces Barnacle Removal System. The report discusses solutions to many of the operational problems but recommends using gravity flow in open channels whenever possible rather than pumping plants and pipelines. The PEIR alternatives use open channels whenever possible to avoid potential fouling problems.

OPERATIONS AND MAINTENANCE

Operation activities would include the daily activities to manage the facilities, such as adjusting water control structures to distribute water or purchasing electricity. Maintenance would include repairs or modifications of the facilities, vegetation control in the water canals, or replacing rock on the Barriers that is lost to settlement or wave action.

Operations and maintenance activities would be divided into the following broad categories:

- Administration;
- Operations and Maintenance; and
- Reserve Fund.

Administration

Administration activities would consist of the financial, legal, and managerial oversight of the facilities, including the following activities:

- Managing the cash flow (bond payment, state/federal contributions, payroll, invoices, etc.);
- Operational decisions;
- Legal issues;
- Ordering supplies;
- Managing construction activities; and
- Emergency management.

Facility Operations and Maintenance

Facility operations and maintenance would include the activities to manage facility operations, repairs, and cleaning. Operations and maintenance would include labor, supplies, power, and periodic replacement. Examples of facilities operations and maintenance activities for each type of infrastructure are listed below:

- **Barriers and Dikes**
  - Security patrols;
  - Inspections for facility condition and safety;
  - Monitoring and repairing areas with seepage;
  - Repair of areas with erosion; and
  - Rock addition to embankments due to settlement over time;

- **Other Habitat**
  - Security patrols;
  - Water flow management at water control structures;
  - Salinity monitoring;
  - Ecosystem studies, monitoring, and data analyses;
  - Dredging of Saline Habitat Complex holes to maintain depth;
  - Berm reconstruction due to settlement over time;
  - Repair of areas with erosion; and
  - Vegetation control;

- **Conveyance**
  - Security patrols;
  - Water flow management at water control structures ;
  - Operation of pumping systems;
  - Repair/replacement of pumps;
  - Vegetation control;
  - Screen cleaning; and
  - Sediment flushing;

- **Treatment**
  - Operate treatment processes and sludge management;
  - Provide electricity and chemicals for treatment process; and
  - Equipment repair/replacement;
- **Air Quality Management**
  - Security patrols;
  - Water flow and salinity management;
  - Provide electricity, fertilizer, and chemicals;
  - Operating pumping and filtration systems;
  - Provide electricity and chemicals for treatment process; and
  - Equipment repair/replacement.

Reserve Fund

A reserve fund is generally used for major repairs or modifications and is funded by a portion of annual operations and maintenance funds. Examples of reserve fund expenditures for each type of infrastructure would include the following activities:

- **Barriers and Dikes**
  - Major repair of the embankments if foundation settlement exceeds design calculations or damage occurs due to earthquakes;
- **Other Habitat**
  - Reconfiguration of Berms, deep holes, islands, and peninsulas to change water depths, allocated water, and land surface for specific habitat cells;
- **Conveyance**
  - Repair/replacement of pumps, canals, and pipelines;
- **Treatment**
  - Repair/replacement of treatment process equipment; and
- **Air Quality Management**
  - Expand facilities to include emissive areas previously considered to be non-emissive; and
  - Repair/replacement of pumps, pipelines, and canal.

Estimate of Operations and Maintenance Personnel

For the PEIR, it was assumed that personnel costs would be 20 percent of operations and maintenance costs for Barriers and Perimeter Dikes, 50 percent of operations and maintenance for Saline Habitat Complex, 50 percent of operations and maintenance for conveyance, 35 percent of operations and maintenance for Air Quality Management, and 20 percent of operations and maintenance for Water Treatment. About 60 percent of the operations and maintenance personnel would be working at a site and 20 percent would be driving vehicles at any given time, as described in Appendix E. Additional workers periodically needed for repairs are in addition to these estimated labor efforts, and were estimated to be less than 2 percent of the work effort expended during the peak year of construction in Phase I. During intensive periodic repairs and replacement efforts, the level of work effort is expected to be over 10 percent of the work effort expended during the peak year of construction. These assumptions were developed for the PEIR because there are no similar projects to compare level of effort. Personnel estimates for each alternative are included in Appendix H-7.

Estimates of Operations and Maintenance Costs

For conceptual studies, including the PEIR, operations and maintenance costs are frequently estimated as a percentage of the estimated construction cost. For the purposes of this PEIR, the annual operations and maintenance budgets were estimated using the following percentages:

- 0.5 percent of the estimated construction cost for Barriers and Perimeter Dikes;
- 1.0 percent of the estimated construction cost for the Saline Habitat Complex, including the Early Start Habitat;
- 2.5 percent of the estimated construction cost for water conveyance facilities; and
- 4.0 percent of the estimated construction cost for the Water Treatment Plants.

The annual operations and maintenance for Air Quality Management was based on $1,500/acre/year for water efficient vegetation, $625/acre/year for stabilization with brine, and $900/acre/year for a combination of types of Air Quality Management, as described in Appendix H-3.

Estimated operations and maintenance costs for each alternative based on this information are presented in Appendix H-7.